PUBLICATIONS

OF THE

Earthquake Investigation Committee

IN

FOREIGN LANGUAGES.

NO. 5.

TŌKYŌ, 1901.

PUBLICATIONS

OF THE

Earthquake Investigation Committee

IN

FOREIGN LANGUAGES.

NO. 5.

TŌKYŌ, 1901.

PRINTED BY THE TOKYO PRINTING COMPANY, LIMITED

RESULTS OF THE HORIZONTAL PENDULUM OBSERVATIONS OF EARTHQUAKES, JULY 1898 TO DEC. 1899, TOKYO.

BY

F. OMORI, D. SC.,

Member of the Imperial Earthquake Investigation Committee.

CONTENTS.

PREFACE.

In 1898 I set up a pair of horizontal pendulums adapted to mechanical registration, in the brick "earthquake-proof house" in the University compound, Hongo, Tokyo, and a description of the apparatus with a discussion on the observations obtained was given in Vol. XI of the Jour. Coll. Sc. Imp. Univ. Tokyo. These observations were continued and I have recorded, between July 1898 and Dec. 1899, 246 earthquakes,* which for the sake of convenience are divided according to origins into the following nine groups.

Group I.—Distant earthquakes.

Group II.—Earthquakes which originated off the eastern coast of Hokkaido (Island of Yeso).

Group III.—Earthquakes which originated off the north-eastern coast of Honshiu (Main Island).

Group IV.—Earthquakes which originated off the coast of the provinces of Hitachi and Iwaki.

Group V.—Earthquakes which originated off the southern coast of Honshiu (Main Island).

Group VI.—Earthquakes which originated in Kiushiu or off its eastern coast.

Group VII.—Earthquakes which originated in central Japan.

---

* Not including a few very small local shocks, whose diagrams were too small to be accurately measured.

Group VIII.—Local earthquakes :—

(a) Those observed at several places.

(b) Those observed in Tokyo and at one other place.

(c) Those observed only in Tokyo.

Group IX.—Earthquakes of miscellaneous origins.

Group I includes large earthquakes which originated at great distances from Japan as well as those comparatively small ones which originated under the ocean at such distances from Japan's eastern coast as to be no longer sensible to the ordinary Gray-Milne type seismographs at the meteorological observatories in different parts of the Empire. The majority of the earthquakes in Groups II to IX originated in Japan itself or off its eastern coast and were felt more or less intensely at several places.

In this volume I give the description of some improved forms of the horizontal pendulum apparatus, the list of the earthquakes, and tables showing the chief elements of motion, together with a few remarks and discussions, chiefly on the earthquakes of Group I. In the next volume, I shall give in detail the analysis of the horizontal pendulum diagrams of the 246 earthquakes.

My horizontal pendulums were recently also set up in the Meteorological Observatory of Miyako, the Seismological Observatory of Hitotsubashi (Tokyo), the Imperial University of Kyoto, and the Astronomical Observatory of Mizusawa. The analysis of the diagrams obtained at these places will be published at some future date. Before the end of this year, similar apparatus will be set up in the Imperial Central Meteorological Observatory (Tokyo), and the Meteorological Observatories of Ishinomaki (in the province of Rikuzen); Osaka; Gifu (in the province of Mino); Keelung, Taihoku, Taichu, Tainan and Koshun (in Formosa); Hokoto (Pescadores), etc.

On Instruments to be used for Micro-Seismic Observations.

To observe earthquakes satisfactorily it is necessary to record the two fundamental elements of the seismic motion, namely, the *period*, and the *amount* or *amplitude*. Hence the requirements of the instruments to be used for international observations of earthquakes will be three-fold, as follows :—

> Firstly, the rate of motion of the record-receiver must be sufficiently rapid to enable us to measure with accuracy the periods of the different waves of an earthquake. Secondly, the so-called *steady-point* (or *stationary mass*) of a seismograph must be brought so nearly into a state of neutral equilibrium, that the period of its free oscillations is sufficiently long to enable us to distinguish between the real earthquake movements and the motions of the instrument itself. Thirdly, the amount of friction between different parts of the instrument must be reduced to a minimum.

If these conditions be fulfilled, the records from the different apparatus will be comparable with each other and there is no need to set up instruments of a single pattern in all the stations of the world. A very common mistake among seismologists is to put too great a confidence in their instruments and ignore the possibility of the existence of the proper oscillations of the *steady point*. If this source of error be properly cared for, the interpretation of seismograms will become considerably simplified.

Jan. 1901. F. Ōmori.

Seismological Institute.

Results of the Horizontal Pendulum Observations of Earthquakes, July 1898 to Dec. 1899, Tokyo.

BY

F. ŌMORI, D. Sc.,

MEMBER OF THE IMPERIAL EARTHQUAKE INVESTIGATION COMMITTEE.

I. Horizontal Pendulums Registering Earth Movements Mechanically.

1. *Introduction.*—The horizontal pendulums I am here going to describe are essentially the same as those which have been in use at the Seismological Institute* since 1898, with certain improvements for rendering their setting up somewhat easier. These machines are constructed on the principle of keeping the heavy *stationary mass* comparatively small and reducing friction to a minimum. By a slight modification of construction and adjustments, these instruments may be used principally either as *seismographs*, namely recorders of earthquakes and other similar earth movements, or as *tiltometers*, namely recorders of changes of level of the ground.

2. *Horizontal pendulum seismograph for standard observatories.*—My first large horizontal pendulums are suspended from the thick parabolic walls of the brick "earthquake-proof house" in the University compound, which is virtually a stout hollow column and therefore may be considered as being safe from disturbances due to the

---

* See the present author's paper: *Horizontal pendulums, etc.* Jour. Sc. Coll. Imp. Univ., Tokyo. Vol. XI., Pt. 2.

direct impact of winds. When, however, such a strong structure is not available, arrangements similar to what is described next may be adopted.

Pl. Ia and Pl. Ib give respectively the elevations and mechanical details of the large seismograph recently set up in the "earthquake-proof house," the following description applying to each of the two exactly similar horizontal pendulums whose planes are mutually at right angles.

The structure from which the horizontal pendulum is hung, consists of a strong cast iron stand *c* 1,2 m. in height, furnished with three levelling screws *d* and fixed by means of the two bolts *e* to the top of a solid stone column *f*, 0,82 m. square and 1,78m high. The latter is indented at *g* so as to bring the point of support of the pendulum nearly vertically below the point of suspension.

The pendulum consists of a thin brass cylinder *a*, filled with lead, 10 cm. in height, 10 cm. in diameter, and 7½ kg. in weight, attached in front of its centre of gravity to a tubular iron strut *b*, 1,5 cm. in diameter and of such a length that the distance between its end and the axis of the cylinder is 1 m.

The heavy bob *a* is suspended from the top of the cast-iron stand, *c*, with two* sufficiently strong iron wires *g*, whose lower ends are attached to a pair of hooks *h* pivoted to the bob at the ends of its central diameter normal to the pendulum plane. The length of the wires *g* can be adjusted by means of a screw *i* (Fig. 1, Pl. Ia), to which they are attached and which passes normally through a closely fitting hole in a steel triangular prism *j*. The edge of the knife has all been cut away except two small portions *k*, on which the prism rests in a V-slot *l* soldered to a thick rectangular brass plate *m* with

* Following the bifilar method of Prof. G. Grablovitz.

an inclination equal to the angle between the bifilar plane and the vertical. The prism has thus no tendency to slide in the V-slot, the point of suspension of the pendulum being determined by the intersection of the line joining the two portions of the knife edge and the axis of the screw *i*. The fine adjustment in the period of vibration of the horizontal pendulum is effected by moving the plate *m* forwards or backwards by means of a screw *o* on the basal plate *n*, which is fixed horizontally on the top of the cast-iron stand *c*. Finally the two screws *p* fixed in the stirrup *q*, rising from the basal plate, secure the plate *p* to the latter. The V-slot *g* is properly perforated to allow the free passage through it of the screw *i*. Rectangular cuttings *r* and *s* have also been made for the same purpose in the two plates *m* and *n*.

The strut *b* (Fig. 2, Pl. Ib) is furnished at the end with a sharp conical steel point of about 50° pivoted in a conical steel socket *t* of about 120°. The azimuthal adjustment of the horizontal pendulum is made by means of the two screws *u* which give a horizontal movement to the brass plate *v*, on which the socket *t* is mounted and which fits closely in the brass frame *w*. The latter is fixed to a cast-iron plate *x*, which is in its turn bolted to the vertical face *y* of the stone column. The vertical height between the point of suspension and that of support of the pendulum is 2,65 m.

The writing pointer (Fig. 3, Pl. Ib) consists of a small steel axis *A* about 2½ mm. in diameter and 4½ cm. in height, to which a light lever *BC* is rigidly attached. The longer arm *B* of the lever consists of a light alminium triangular frame, while the shorter forked arm *C* is of brass. The small weight *D* is to be properly adjusted along the screwed part of the arm *C* in such a way that the centre of gravity of the whole pointer coinsides with the axis *A*. The latter, pivoted between two small conical steel sockets *E* (Fig. 4, Pl. Ib), fixed in

an inverted brass stirrup F, is adjustable along the horizontal rod G of the same metal. The latter is fixed in proper azimuth and height by means of the screw H to a stout steel cylinder I rising from the cast-iron truncated cone J, which is furnished with three levelling screws K and rests on the ground.

Between the two limbs of the shorter arm C of the pointer there is an exactly fitted, highly polished steel axis L (Figs 2 and 4), 2½ mm. in diameter and 2½ cm. in height, which forms a prolongation of the central line of the heavy bob a and which is pivoted in a stirrup M fixed to the upper end of the latter.

To a small U-shaped frame of brass N at the end of the alminium arm of the pointer is hinged an exceedingly light writing index O made of a thin triangular piece, about 5 mgm in weight, cut from a watch spring. The point of the index rests on the record-receiving smoked smooth paper wrapped round the light wooden drum P. The effective lengths of the two arms of the pointer are respectively 300 and 30 mm, the multiplication being therefore 10. The total weight of the pointer is 24 gr.

The wooden drum P, about ¼ kg. in weight, 750 mm. in circumference and 350 mm. in length, consists of a thin mantle of wood, strengthened by an inner hoop at the middle of its length, the axis being a brass tube about 1 cm. in diameter. Further, to prevent the deformation of the mantle, each end is composed of a frame of the same wood, made up of exactly similar radial pieces. The drum, which is turned at the rate of one revolution in an hour by the continuous clock-work Q regulated by an air governor, has at the same time a slow motion of translation in the direction of its axis, one of the external prolongations of the latter being screw-cut.

The rotation of the drum is recorded by the electric time ticker

R, which is in circuit with a chronometer, one mark being made every complete minute of time.

Finally, the whole apparatus and the stone column are covered with a glass case, to protect against winds.

It may be noted that in countries much disturbed by earthquakes, like Japan, the multiplication-ratio of the writing pointer should generally be not much greater than 10, as otherwise the pointer may often be thrown off the record-receiver. Thus, even with the multiplication of 10, I have five times experienced such a behaviour of the writing pointer in the course of the two years 1898–1899, the distances of the earthquake origins from Tokyo varying between 140 and 1500 km.

The longest period of vibration, at which the pendulum can be kept stable is about 3 m. It is however convenient not to make the period much longer than 100 s or 2 m, as otherwise the writing index of the pointer assumes too wide a range in the diurnal and other oscillations, and as also the displacement of the zero position of the pendulum may easily occur on the occasion of sharp local earthquakes.

The pendulum, though designed principally for the observation of earthquakes, is also very sensitive to the change of level of the ground. Thus with a period of 2 m, 1 mm displacement of the writing index on the smoked paper would correspond to an angle a given by the equation

$$a'' = \frac{T_0^2}{T^2 \, Ln \, \sin 1''} \quad \ldots\ldots\ldots \ldots\ldots\ldots (1)$$

$$= 0'',0057$$

In the above equation, N is the multiplication-ratio of the pointer, L the distance between the centre of the heavy bob and the pointed

end of the strut, T the period of vibration of the horizontal pendulum, and T_0 the period when the pendulum is suspended vertically.

Stability of the column. The extreme sensitiveness of this horizontal pendulum to the tilting may be utilized for testing the stability of the stone column on which the cast-iron stand is fixed. Thus the column can, notwithstanding its size, be slightly bent by a lateral pressure. For instance a movement of 5 mm of the writing index can easily be produced by a hand pressure applied horizontally at the upper margin of the column, the period of vibration of the pendulum being 90 s. Expressed in angular measurement, this displacement represents a deviation a from the vertical of the line joining the points of suspension and of support, given by the following equation

$$a'' = \frac{5\ T_0^2}{n\ L\ T^2 \sin 1''} = 0'',051.$$

Similar movement of the pendulum can also easily be produced by putting a weight on the stone clumn. These experiments show the necessity of precaution about the weight of the observer himself in delicate astronomical and geodetical measurements.

3. *Portable apparatus.*—Pl. II illustrates an improved portable form of the horizontal pendulum apparatus, figs. 1 and 2 giving the front and side elevations.

The heavy bob of the pendulum is a flat brass cylinder a filled with lead, 12 cm. in diameter, 5 cm. in height and about 6,4 kg. in weight, attached in front of its centre of gravity to a strut b, which is an iron rod, 8 mm. in diameter, furnished at the end with a sharp steel conical point of about 70°. The strut is pivoted in a steel conical socket c at the base of a strong cast-iron stand d, from whose top the pendulum bob a is hung bifilarly with sufficiently strong iron wires e by means of the two hooks f. The stand d, which is furnished with three levelling screws g, is fixed to a stone column by

means of the two bolts *h*. The vertical height of the point of suspension above that of support is 75 cm. and the horizontal distance between the latter and the axis of the heavy cylinder also 75 cm. The maximum length of the period of vibration at which the pendulum can be kept stable is about 1 m.

The pendulum is furnished with a light writing pointer which multiplies 10 times the horizontal motion of the ground, and whose construction is similar to those employed in my first apparatus. The pointer-holder and the record-receiver are exactly the same as those for the larger apparatus descrived in § 2. (The time-ticker is not shown in the figures.)

Fig. 3, Pl. II, illustrates the mechanism at the top of the cast-iron stand, by means of which the necessary adjustments can be made. The strut *b* is adjusted to a nearly horizontal position by means of a screw *i*, to which the suspension wires are attached, and which passes normally through a closely fitting hole in a steel triangular prism *j*. The edge of the knife has all been cut away except two small portions *k*, on which the prism rests in a V-slot *l*, in the inclined hypothenuse face of an isosceles right-angular iron prism *m*, soldered to a large square screw *n*. The latter passes through two closely fitting stirrups *o*, attached to a thick brass plate *p*, and the azimuthal position of the heavy cylinder *a* can be adjusted by appropriate movements of the screw *n* by means of the two nuts *q*. For properly adjusting the period of vibration of the horizontal pendulum, the whole system is, in its turn, made to move forward and backward on the basal plate *r* by means of a screw *s*. Finally, the two screws *t*, fixed in the stirrup *u* rising from the basal plate, secure the plate *p* to the latter.

The right-angled prism *m* is so perforated as to allow the free passage through it of the screw *i*. Rectangular cuttings *v* and *w* have also for the same purpose been made in the two plates *p* and *r*. The

plate r is fixed to the top of the cast-iron stand d with such an angle of inclination that the suspension wires are at right angles to the knife-edge.

4. *Small multiplication apparatus.*—Pl. III illustrates a simpler form of the portable horizontal pendulum apparatus. The cast-iron stand, the record-receiver and the heavy bob of the pendulum are exactly similar to those of the instrument described in § 3. The differences are :-1) the distance between the point of the strut b and the centre of the bob a is only 12 cm.; 2) the small writing index d is hinged to the end of a light pointer c, which forms the prolongation of the strut and which is attached to a triangular frame of the same metal.* The distance between the index d and the centre of the bob a is 48 cm., the horizontal motion of the ground in direction normal to the pendulum plane being thus multiplied 5 times.

The advantage of this form of the horizontal pendulum is that there is no friction between its different parts except between the writing index d and the record-receiving smoked paper ; the weight of the index can, however, be made as small as 5 mgm. or even less, thus reducing the friction to a minimum. The disadvantage is that the period of free oscillations of the pendulum can not be made so great as in the apparatus with a longer strut. The period, however, can be raised to 30 or 35 s. The multiplication ratio, if desired, can be raised to 8 or 10. This type of instrument is easy to handle and therefore to be recommended for use in subordinate observatories.

5. *Two components apparatus.*—Even with the moderate multiplication-ratio of 10, the motion of the ground is sometimes so powerful as to cause the writing index to run off the record-receiver. Hence it is desirable for the sake of completeness to have separate recording

* This form is essentially similar to the horizontal pendulum apparatus of Prof. G. Gerevlevitz.

apparatus for the two horizontal pendulums in the EW and NS directions. A great amount of labour, however, can be saved by causing the two horizontal pendulums to write on one and the same record-receiver.

For this purpose, one of the pendulums is to be constructed in the ordinary way (§3), while the other pendulum ought to have the shorter arm of the pointer bent at right angles to its longer arm.

II. Horizontal Pendulum Observations of Earthquakes, July 1898 to Dec. 1899, Hongo, Tokyo.

6. *Number of earthquakes observed.*—As stated in Preface, 246 earthquakes were observed during 1½ years between July 1898 and Dec. 1899. These are numbered 1 to 246 in order of date, their distribution into the groups being as follows :—

Group	I	95	earthquakes
,,	II	10	,,
,,	III	42	,,
,,	IV	21	,,
,,	V	3	,,
,,	VI	6	,,
,,	VII	5	,,
,,	VIII a	38	,,
,,	VIII b	10	,,
,,	VIII c	12	,,
,,	IX	4	

7. ***The instruments.***—**All the observations, un[illegible] stat-ed, were made in the "earthquake-proof house" [illegible]niversity**

[illegible] by means of the horizontal pendulum apparatus* A and [illegible] the following specification.

Horizontal pendulum A ; EW component apparatus, at Hongo:—

> Period† of free oscillation = 28 s.
> Multiplication of the pointer = 10.
> Weight of the heavy cylinder = 14 kg.
> Length of the horizontal strut, or the distance between the centre of the heavy cylinder and the point of support = 1 m.
> Vertical distance between the points of support and of suspension = 2,5 m.

Horizontal pendulum B ; NS component apparatus, at Hongo:—

> Period of free oscillation = 17 s.
> Multiplication of the pointer = 8,2.

In other respects B is exactly similar to A.

In the three cases of eqkes Nos. 234, 236 and 237, where the records from the apparatus A were not satisfactory I have substituted those from the newly constructed long-period horizontal pendulum C, also set up in the "earthquake-proof house," (described in § 2), of the following specification.

Horizontal pendulum C ; EW component apparatus, at Hongo:—

> Period of free oscillation = 120 s. ‡
> Multiplication of the pointer = 10.
> Weight of the heavy cylinder = 7½ kg.
> Length of the horizontal strut = 1 m.
> Vertical distance between the points of support and of suspension = 2,5 m.

---

* Described in Vol. XI of the Jour. Coll. Sc. Imp. Univ. Tokyo.
† The term *period* is used always in the sense of the *complete period*.
‡ In July 1900, the period was changed to 60,0 s.

In the discussions on the nature of the seismic movements proceeding from distant origins and of the non-seismic micro-pulsations of the ground, called *pulsatory oscillations*, I have referred, §§ 23 and 31, to the diagrams obtained from the horizontal pendulum D at Hitotsubashi, which is exactly of the form described in § 4 and has the following specification.

Horizontal pendulum D; EW component apparatus, at Hitotsubashi:—

Period of free oscillation=29,7 s.
Multiplication of the pointer=8,4.
Weight of the heavy cylinder=6,4 kg.
Length of the horizontal strut=75 cm.
Vertical distance between the points of support and of suspension=75 cm.

8. *The character of the earthquake motion.*—Broadly speaking, the motion of an earthquake may be divided more or less definitely into three successive stages:—the *preliminary tremor*, the *principal portion* and the *end portion*, defined as follows.

The *preliminary tremor* of an earthquake consists essentially of vibrations of small amplitude and of very short, or comparatively short, period.

The *principal portion* denotes the most active part of an earthquake, which follows the preliminary tremor and which consists of movements of larger amplitude.

The *end portion* denotes the feeble finishing part of an earthquake, which follows the principal portion.

In cases of large earthquakes proceeding from distant orignis, the preliminary tremor and the principal portion may each be further subdivided as follows.

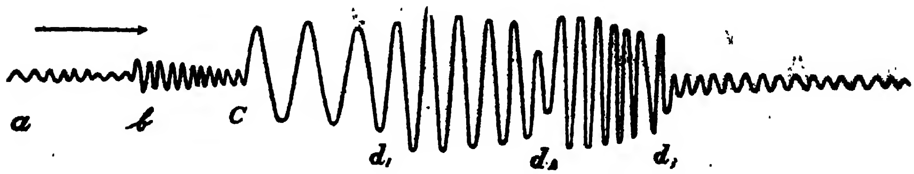
The *preliminary tremor* is made up of two distinct portions, which may be termed respectively the *1st preliminary*

tremor and the *2nd preliminary tremor.*—The 1st preliminary tremor denotes the earlier portion, and the 2nd preliminary tremor, the later portion of the preliminary tremor ; the beginning of the latter being distinguished by a well marked increase of the amplitude and, in many cases, also by the appearance of slow undulations. In each of the two preliminary tremors, the period remains on the whole constant, the amplitude also remains generally constant or, as often happens, rather greater at the commencement than towards the end.

The *principal portion* is made up essentially of three successive parts, which may be termed respectively the *initial phase*, the *slow-period phase* and the *quick-period phase.*—The *initial phase* denotes the introductory part of the principal portion, which consists of a few slow undulations. The *slow-period phase* follows the initial phase and consists of a number of slow undulations. These two phases are distinguished from one another by the difference of amplitude and period. The *quick-period phase* occurs towards the end of the principal portion and consists of comparatively quick waves. The period remains constant in each of the two last phases.

In distant earthquakes the period remains essentially constant throughout the *end portion*. With earthquakes of near origins it may sometimes be different, since there exist, in these cases, various kinds of waves, some of which may gradually disappear towards the end.

The successive different stages of the earthquake motion are illustrated diagramatically in the accompanying figure.



a ....Beginning of the eqke.
ac.........Preliminary tremor.
ab.........1st preliminary tremor.
bc.........2nd ,, ,,

cd_3.........Principal portion.
- cd_1........Initial phase.
- d_1d_2.......Slow-period phase.
- d_2d_3.......Quick-period phase.

d_3e.........End portion.

9. *The analysis of the seismograms.*—I have analyzed each of the diagrams of the 246 earthquakes on the supposition that the waves recorded are *horizontal movements* and not tiltings of the ground*; that is, the range of motion or double amplitude, denoted by 2a, was in each case deduced by dividing the actual trace on the seismogram by the multiplication ratio of the pointer of the instrument. If the reader wants to consider the movements as due to the tilting, he can at once obtain the magnitude of the recorded trace by multiplying the results I give by the multiplication ratio of the pointer.

10. *Tables.*—I shall now give Tables embodying the chief results obtained from the measurements of the 246 earthquakes.

Table I gives the list of the earthquakes.

Tables II, III, IV, V, VI, VII, VIII, IX and X give, respectively for the earthquakes of the Groups I, II, III, IV, V, VI, VII, VIII and IX, some or all of the following elements of motion.—

Date and time of occurrence ;

Total duration ;

Durations of the 1st and 2nd preliminary tremors and of the principal portion ;

---

¹ See §§ 21-27.

Average period of waves in the 1st and 2nd preliminary tremors, the principal portion and the end portion ;

Maximum range of motion, or double amplitude, in the 1st and 2nd preliminary tremors and the principal portion.

With respect to the 1st and 2nd preliminary tremors, I have given separately the average period for the two series of the slower and the quicker waves, which exist one superposed upon the other.

Table II is divided into two portions [A] and [B]; [A] including those earthquakes whose durations varied between ¾h and 4hs, and [B] the rest of the Group I.

11. *Terminology.*—I use the terms *waves*, *vibrations* and *undulations* all in the same sense of periodic movements, with this distinction : *vibrations* denote waves with quicker period, while *undulations* denote those with slower period.

TABLE I.—List of 246 Earthquakes Observed at Hongo, Tokyo, July 1898 to Dec. 1899, with Ōmori's Horizontal Pendulum Apparatus.

No.	Group.	Date.	Time of occurrence.*				Total duration.		
			h	m	s		h	m	s
1	VIII a	July 14th 1898.	7.	8.	59	p.m.	0.	2.	30
2	I	„ 15th „	2.	6.	14	a.m.	1.	4.	0
3	IV	„ „ „	5.	10.	22	a.m.	0.	6.	0
4	III	„ 20th „	6.	46.	14	p.m.	0.	14.	0
5	IX	„ 25th „	6.	18.	2	a.m.	0.	30.	0
6	VIII c	„ „ „	6.	37.	57	a.m.	0.	0.	41
7	VIII a	„ „ „	0.	17.	4	p.m.	0.	11.	0
8	VIII a	„ 27th „	2.	35.	2	a.m.	0.	10.	0
9	VII	Aug. 1st „	2.	12.	21	p.m.	0.	6.	0
10	VIII a	„ 7th „	11.	2.	56	p.m.	0.	8.	0
11	I	„ 8th „	4.	57.	35	p.m.	1.	20.	0
12	VI	„ 10th „	10.	0.	50	p.m.	0.	9.	30
13	VIII a	„ 11th „	5.	40.	37	p.m.		(?)	
14	VI	„ 12th „	8.	38.	42	a.m.	0.	30.	0
15	VIII c	„ 17th „	4.	26.	50	p.m.	0.	1.	0
16	III	„ 21st „	0.	8.	22	a.m.	0.	45.	0
17	III	„ „ „	1.	28.	44	a.m.	0.	15.	0
18	IV	„ 22nd „	11.	31.	58	p.m.	0.	6.	20
19	III	„ 23rd „	8.	5.	17	a.m.	0.	5.	0
20	IV	„ „ „	11.	42.	58	a.m.	0.	8.	24
21	IV	„ „ „	11.	47.	17	a.m.	0.	8.	0
22	I	Sept. 1st „	5.	0.	57	a.m.	1.	45.	0
23	I	„ „ „	6.	2.	17	p.m.	0.	50.	0
24	I	„ 4th „	0.	26.	58	a.m.	0.	36.	0
25	VIII a	„ „ „	3.	58.	21	p.m.	0.	1.	45
26	VIII a	„ 5th „	4.	47.	35	p.m.	0.	1.	30
27	VIII a	„ 7th „	1.	6.	38	p.m.	0.	0.	48
28	VIII b	„ 11th „	10.	3.	32	p.m.	0.	1.	7
29	I	„ 14th „	3.	2.	10	a.m.	1.	0.	0
30	III	„ 15th „	7.	18.	37	[illegible]	0.	8.	30

* The time is given in the First Normal Japan Time, namely that of long. 135° E.

No.	Group.	Date.	Time of occurrence.				Total duration.		
			h	m	s		h	m	s
31	III	Sept. 16th 1898	4.	43.	32	a. m.	0.	17.	0
32	IV	" " "	8.	32.	40	a. m.	0.	12.	0
33	I	" 22nd "	9.	26.	11	p. m.	3.	0.	0
34	II	" 24th "	9.	14.	42	a. m.		(?)	
35	I	" 25th "	9.	22.	46	p. m.	0.	30.	0
36	III	" 26th "	10.	27.	44	a. m.	0.	12.	0
37	IV	" 27th "	10.	19.	52	a. m.	0.	16.	0
38	VIII a	" 28th "	1.	40.	49	a. m.	0.	10.	0
39	IV	" " "	7.	53.	40	a. m.	0.	9.	0
40	I	Oct. 1st "	1.	29.	12	a. m.	0.	4.	0
41	VIII a	" 6th "	4.	52.	22	a. m.	0.	1.	15
42	II	" 7th "	11.	1.	36	a. m.	0.	37.	0
43	I	" 10th "	7.	35.	39	a. m.	0.	48.	0
44	I	" 12th "	1.	45.	38	a. m.	2.	30.	0
45	I	" 19th "	4.	27.	48	a. m.	0.	39.	0
46	VIII a	" 20th "	3.	15.	46	p. m.	0.	1.	14
47	I	" 22nd "	9.	2.	42	a. m.	1.	7.	0
48	I	" " "	10.	35.	58	p. m.	0.	20.	0
49	VIII a	" 26th "	10.	30.	14	a. m.	0.	2.	44
50	I	Nov. 2nd "	8.	48.	15	p. m.	0.	17.	0
51	I	" 5th "	8.	48.	45	p. m.	0.	15.	0
52	VIII c	" 6th "	9.	0.	50	a. m.	0.	15.	0
53	III	" 7th "	2.	56.	47	a. m.	0.	18.	0
54	VIII a	" 12th "	2.	42.	40	a. m.	0.	2.	0
55	VIII a	" " "	9.	42.	25	a. m.	0.	12.	0
56	VII	" 13th "	11.	33.	3	a. m.	0.	18.	0
57	I	" 14th "	4.	5.	23	p. m.	0.	40.	
58	I	" 17th "	9.	54.	53	p. m.	2.	30.	0
59	VIII a	" 20th "	3.	42.	4	a. m.	0.	1.	30
60	VIII b	" 21st "	9.	5.	53	a. m.		(?)	

No.	Group.	Date.	Time of occurrence.	Total duration.
			h m s	h m s
61	I	Nov. 22nd 1898	8. 20. 8 p. m.	1. 18. 10
62	VIII a	" 28th "	7. 2. 34 a. m.	0. 2. 0
63	IV	" " "	10. 56. 10 p. m.	(?)
64	I	" 30th "	7. 31. 18 a. m.	0. 17. 0
65	I	Dec. 1st "	9. 58. 58 p. m.	0. 33. 0
66	VI	" 4th "	1. 45. 32 a. m.	0. 19. 0
67	VIII a	" 5th "	0. 47. 58 a. m.	0. 8. 0
68	III	" 7th "	9. 12. 50 a. m.	0. 10. 0
69	I	" 11th "	8. 39. 22 p. m.	1. 18. 0
70	III	" 13th "	1. 34. 48 a. m.	0. 19. 0
71	III	" 14th "	8. 27. 15 p. m.	0. 1. 10
72	VIII b	" 19th "	0. 0. 15 p. m.	0. 1. 10
73	VIII a	" 25th "	0. 46. 56 a. m.	0. 8. 0
74	VIII c	" 27th "	4. 43. 42 p. m.	0. 0. 42
75	VIII c	" 29th "	4. 12. a. m.	0. 8. 0
76	I	" 30th "	11. 28. 49 p. m.	0. 18. 0
77	VIII a	Jan. 1st 1899	1. 49. 45 a. m.	0. 2. 30
78	VIII c	" 5th "	9. 1. 8 a. m.	0. 0. 50
79	VIII b	" 8th "	1. 11. 21 a. m.	0. 2. 35
80	VIII a	" 14th "	11. 30. 42 a. m.	0. 0. 30
81	VII	" 22nd "	8. 4. 3 a. m.	0. 18. 0
82	I	" 23rd "	11. 9. 57 a. m.	0. 27. 0
83	VIII a	" " "	2. 55. 38 p. m.	0. 0. 40
84	I	" 27th "	10. 47. 32 p. m	0. 7. 30
85	III	Feb. 1st "	1. 34. 55 a. m.	0. 54. 0
86	I	" " "	2. 52. 48 p. m.	0. 26. 0
87	VII	" 6th "	4. 7. 54 a. m.	0. 8. 0
88	I	" 11th "	4. 52. 3 p. m.	0. 27. 0
89	III	" 13th "	4. 29. 49 a. m.	(?)
90	III	" 20th "	7. 37. 58 a. m.	0. 5. 0

No.	Group	Date.	Time of occurrence.				Total duration.		
			h	m	s		h	m	s
91	VIII c	Feb. 21st 1899	1.	11.	5	a. m.		(?)	
92	IV	,, 22nd ,,	8.	2.	18	a. m.	0.	16.	0
93	I	,, 28th ,,	11.	48.	55	a. m.	1.	30.	0
94	III	,, ,, ,,	11.	16.	0	p. m.	0.	5.	0
95	I	March 3rd ,,	9.	50.	2	a. m.	0.	20.	0
96	VIII a	,, 6th ,,	8.	11.	40	p. m.	0.	6.	0
97	I	,, ,, ,,	11.	36.	8	p. m.	0.	25.	0
98	I	,, 7th ,,	4.	39.	50	a. m.	1.	0.	0
99	V	,, ,, ,,	9.	55.	29	a. m.	1.	30.	0
100	V	,, ,, ,,	3.	42.	50	p. m.	0.	9.	0
101	VIII c	,, 13th ,,	10.	51.	53	p. m.	0.	0.	30
102	I	,, 15th ,,	6.	9.	14	a. m.	0.	21.	0
103	III	,, 16th ,,	4.	49.	14	a. m.	0.	27.	0
104	VIII a	,, ,, ,,	8.	54.		p. m.		(?)	
105	III	,, 20th ,,	3.	25.	47	a. m.	0.	21.	0
106	III	,, ,, ,,	4.	12.	29.	p. m.	0.	16.	0
107	I	,, 21st ,,	11.	35.	44.	p. m.	0.	44.	0
108	III	,, 22nd ,,	7.	22.	36.	p. m.	0.	23.	0
109	IV	,, ,, ,,	8.	22.	2.	p. m.	0.	5.	0
110	I	,, 23rd ,,	8.	30.	59.	p. m.	0.	23.	0
111	I	,, ,, ,,	9.	23.	14	p. m.	0.	28.	0
112	VI	,, 24th ,,	1.	2.	35	p. m.	1.	9.	0
113	I	,, ,, ,,	0.	29.	5	a. m.		—	
114	VIII a	,, ,, ,,	6.	39.	40	p. m.	0.	4.	30
115	IV	,, 26th ,,	6.	46.	45	a. m.	0.	15.	0
116	VIII c	,, 29th ,,	11.	42.	14	p. m.	0.	3.	30
117	VIII a	April 2nd ,,	11.	1.	7	p. m.	0.	5.	30
118	VIII a	,, 5th ,,	1.	0.	53	p. m.	0.	9.	0
119	V	,, 6th ,,	8.	30.	22	a. m.	0.	19.	0
120	III	,, 9th ,,	5.	42.	22	p. m.	0.	18.	0

No.	Group.	Date.	Time of occurrence.				Total duration.		
			h	m	s		h	m	
121	VIII b	April 11th 1899	10.	5.	45	a. m.	0.	1.	0
122	III	„ 13th „	4.	29.	57	a. m.	0.	2.	30
123	IV	„ 15th „	0.	40.	26	a. m.	0.	7.	0
124	VIII a	„ „ „	7.	25.	30	p. m.	0.	33.	0
125	III	„ 16th „	2.	27.	28	p. m.	0.	17.	0
126	I	„ „ „	11.	1.	34	p. m.	1.	5.	0
127	I	„ 17th „	10.	46.	50	a. m.	1.	57.	0
128	III	„ 19th „	8.	13.	6	p. m.	0.	2.	30
129	VIII b	„ 20th „	5.	0.	31	p. m.	0.	0.	50
130	I	„ 23rd „	0.	15.	2	a. m.	0.	8.	0
131	VIII a	„ 24th „	6.	36.	59	a. m.	0.	5.	0
132	VIII a	May 2nd „	1.	2.	22	a. m.	0.	6.	0
133	I	„ „ „	11.	36.	47	p. m.	1.	0.	0
134	VIII a	„ 4th „	10.	27.	28	a. m.	0.	1.	0
135	VIII a	„ 6th „	2.	8.	34	p. m.	0.	2.	0
136	II	„ 8th „	0.	28.	54	p. m.	1.	20.	0
137	VIII b	„ 11th „	5.	59.	12	a. m.	0.	6.	0
138	I	„ 14th „	10.	56.	31	p. m.	0.	24.	0
139	I	„ 15th „	9.	57.	58	p. m.	0.	37.	0
140	I	„ 18th „	4.	1.	45	a. m.	0.	30.	0
141	I	„ 26th „	11.	38.	28	p. m.	0.	18.	0
142	II	June 5th „	8.	46.	32	a. m.	0.	25.	0
143	I	„ „ „	1.	37.	48	p. m.	2.	0.	0
144	VIII b	„ 10th „	10.	36.	56	p. m.	0.	5.	0
145	I	„ „ „	8.	35.	20	p. m.	0.	38.	0
146	I	„ 13th „	4.	31.	18	a. m.	0.	26.	0
147	I	„ 14th „	8.	27.	46	p. m.	1.	24.	0
148	III	„ 15th „	8.	49.	41	p. m.	0.	25.	0
149	I	„ 16th „	2.	49.	10	p. m.	0.	25.	0
150	III	„ 17th „	10.	9.	35	a. m.	1.	19.	0

No.	Group.	Date.	Time of occurrence.				Total duration.		
			h	m	s		h	m	s
151	III	June 18th 1899	1.	52.	27	p. m.	0.	24.	0
152	I	„ 19th „	9.	2.	22	p. m.	0.	31.	0
153	I	„ 24th „	11.	46.	3	a. m.	0.	15.	0
154	I	„ 25th „	1.	12.	28	a. m.	0.	33.	0
155	I	„ „ „	2.	25.	42	a. m,	0.	36.	0
156	I	July 4th „	0.	44.	11	a. m.	0.	24.	0
157	VIII a	„ 7th „	5.	12.	49	a. m.	0.	5.	0
158	VIII c	„ „ „	6.	32.	16	a. m.	0.	1.	0
159	VIII a	„ „ „	6.	58.	17	a. m.	0.	8.	0
160	II	„ 11th „	7.	15.	44	a. m.	0.	25.	0
161	II	„ „ „	4.	40.	7	p. m.	1.	20.	0
162	I	„ 12th „	11.	56.	26	p. m.	1.	25.	0
163	I	„ 14th „	9.	6.	3	p. m.	3.	0.	0
164	II	„ „ „	11.	21.	0	a. m.	1.	37.	0
165	I	„ „ „	1.	59.	28	p. m.	2.	2.	0
166	I	„ „ „	7.	48.	2	p. m.	0.	29.	0
167	III	„ 18th „	1.	59.	0	a. m.	0.	20.	0
168	I	„ 21st „	7.	25.	55	a. m.	0.	18.	0
169	I	„ 24th „	10.	28.	33	a. m.	1.	45.	0
170	VIII a	„ 27th „	2.	1.	5	p. m.	0.	8.	0
171	I	„ 29th „	6.	23.	18	a. m.	0.	20.	0
172	I	„ 30th „	4.	44.	6	a. m.	0.	41.	0
173	I	„ 31st „	1.	30.	11	a. m.	0.	22.	0
174	IV	Aug. 1st „	9.	39.	57	a. m.	0.	6.	0
175	IV	„ 3rd „	1.	34.	52	a. m.	0.	10.	0
176	III	„ „ „	6.	52.	57	p. m.	0.	20.	0
177	I	„ 4th „	1.	50.	2	p. m.	2.	19.	0
178	IV	„ 5th „	9.	18.	53	a. m.	0.	8.	0
179	VIII a	„ 7th „	6.	11.	22	p. m.	0.	5.	0
180	VIII a	„ 8th „	9.	53.	41	p. m.	0.	5.	0

No.	Group.	Date.	Time of occurrence.				Total duration.		
			h	m	s		h	m	s
181	II	Aug. 10th 1899	4.	59.	51	a. m.	0.	18.	0
182	III	,, 13th ,,	2.	26.	17	p. m.	0.	7.	0
183	VI	,, ,, ,,	8.	0.	2	p. m.	0.	4.	0
184	III	,, 14th ,,	8.	48.	24	a. m.	0.	7.	0
185	I	,, ,, ,,	8.	55.	20	p. m.	0.	6.	30
186	I	,, 18th ,,	5.	46.	32	a. m.	1.	10.	0
187	I	,, 21st ,,	1.	11.	44	a. m.	0.	22.	0
188	I	,, 25th ,,	0.	20.	7	a. m.	1.	10.	0
189	I	,, 26th ,,	7.	7.	11	a. m.	0.	20.	0
190	I	,, ,, ,,	1.	58.	29	p. m.	0.	20.	0
191	VIII b	Sept. 2nd ,,	3.	15.	45	a. m.	0.	9.	0
192	VIII a	,, 3rd ,,	10.	7.	54	p. m.	0.	5.	0
193	I	,, 4th ,,	9.	31.	59	a. m.	3.	0.	0
194	III	,, 9th ,,	9.	46.		a. m.	0.	15.	0
195	III	,, ,, ,,	11.	0.	34	a. m.	0.	42.	0
196	I	,, 11th ,,	3.	14.	16	a. m.	3.	0.	0
197	I	,, ,, ,,	6.	50.	58	a. m.	4.	0.	0
198	I	,, ,, ,,	8.	44.	35	p. m.	0.	19.	0
199	III	,, 13th ,,	11.	5.	56	p. m.	0.	14.	0
200	I	,, 17th ,,	10.	1.	8	p. m.	2.	0.	0
201	I	,, 20th ,,	11.	24.	27	a. m.	1.	15.	0
202	I	,, 23rd ,,	8.	26.	22	p. m.	0.	24.	0
203	I	,, ,, ,,	11.	8.	45	p. m.	0.	28.	0
204	IV	,, 27th ,,	1.	57.	39	a. m.	0.	4.	30
205	I	,, 28th ,,	3.	58.	14	p. m.	0.	19.	0
206	I	,, 29th ,,	8.	40.	28	p. m.	0.	17.	0
207	I	,, 30th ,,	2.	11.	0	a. m.	2.	0.	0
208	III	Oct. 1st ,,	11.	55.	22	a. m.	0.	24.	0
209	IV	,, 3rd ,,	6.	28.	8	p. m.	0.	6.	0
210	I	,, 4th ,,	5.	56.	22	p. m.	1.	5.	0

No.	Group.	Date.	Time of occurrence.				Total duration.		
			h	m	s		h	m	s
211	I	Oct. 5th 1899	5.	24.	49	a. m.		(?)	
212	IX	„ 7th „	0.	59.	38	a. m.		(?)	
213	VIII b	„ 10th „	1.	12.	43	a. m.	0.	8.	0
214	VIII a	„ „ „	6.	17.	54	a. m.	0.	5.	0
215	IV	„ „ „	6.	47.	26	p. m.	0.	3.	0
216	IX	„ 11th „	2.	17.	20	p. m.	0.	14.	0
217	I	„ 14th „	0.	38.	5	a. m.	1.	39.	0
218	I	„ „ „	2.	55.	24	a. m.	2.	15.	0
219	I	„ 17th „	5.	32.	56	p. m.		(?)	
220	I	„ 19th „	6.	28.	59	p. m.	2.	0.	0
221	III	„ 21st „	10.	8.	9	p. m.	0.	8.	0
222	I	„ 24th „	1.	3.	29	p. m.	2.	36.	0
223	III	„ 29th „	11.	18.	47	p. m.	0.	3.	0
224	III	Nov. 3rd „	1.	39.	21	p. m.	0.	29.	0
225	IX	„ 6th „	0.	34.	0	a. m.	0.	20.	0
226	III	„ „ „	7.	53.	47	p. m.	0.	20.	0
227	VIII c	„ 7th „	4.	48.	50	p. m.	0.	1.	20
228	II	„ 10th „	8.	58.	25	p. m.	1.	0.	0
229	III	„ 11th „	2.	40.	24	a. m.	1.	0.	0
230	III	„ „ „	7.	10.	0	a. m.	0.	35.	0
231	I	„ 12th „	7.	27.	13	a. m.	1.	10.	0
232	II	„ 18th „	4.	28.	8	p. m.	0.	38.	0
233	VII	„ 21st „	6.	56.	29	p. m.	0.	20.	0
234	I	„ 23rd „	6.	52.	39	p. m.	4.	0.	0
235	I	„ 24th „	7.	2.	1	p. m.	2.	0.	0
236	VI	„ 25th „	3.	45.	24	a. m.	2.	18.	0
237	VI	„ „ „	3.	58.	48	a. m.			
238	I	Dec. 4th „	9.	32.	1	a. m.	0.	40.	0
239	III	„ 10th „	11.	22.	21	p. m.	1.	0.	0
240	III	„ 12th „	3.	43.	27	p. m.	0.	16.	0

No.	Group.	Date.	Time of occurrence.	Total duration.
			h m s	h m s
241	VIII c	Dec. 14th 1899	2. 29. 36 a. m.	0. 2. 30
242	IV	„ 20th „	10. 46. 29 a. m.	0. 13. 0
243	I	„ 24th „	8. 52. 35 p. m.	0 10. 0
244	I	„ 25th „	6. 8. 45 a. m.	(?)
245	I	„ 28th „	3. 34. 43 a. m.	0. 25. 0
246	IV	„ 31st „	9. 40. 17 a. m.	0. 3. 30

TABLE II.—DISTANT EARTHQUAKES (GROUP I)

Abbreviations.*
- 1st P. T. ....1st preliminary tremor.
- 2nd P. T. ....2nd ,, ,,
- P. T. ....Total ,, ,,
- P. P. ....Principal portion.
- E. P. ....End portion.

[A] Earthquakes whose durations varied between ¾ h and 4hs.

No.	Date.	Time of occurrence.	Duration of					Average period in								Max. range of motion in									
			Total eqke.	1st P. T.	2nd P. T.	P. T.	P. P.	1st P. T.		2nd P. T.		P. P.			E. P.	1st P. T.		2nd P. T.		P. P.					
								Slower waves.	Quicker waves.	Slower waves.	Quicker waves.	Initial phase.	Slow-per. phase.	Quick-per. phase.		(EW)	(NS)	(EW)	(NS)	Initial ph. (EW)	Initial ph. (NS)	Slow-per. ph. (EW)	Slow-per. ph. (NS)	Quick-per. ph. (EW)	Quick-per. ph. (NS)
		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
2	July 15, 1898	2. 6.14 a.m.	1. 4	7.21	7.14	14.35	7.54	—	5,0	8,8	3,1	—	—	10,5	9,0	0,02	0,02	0,13	0,10	—	—	—	—	0,35	0,55
11	Aug. 8, ,,	4.57.35 p.m.	1.20	—	—	6.56	17. 0	8,4	4,2	—	—	—	21,2	10,5	10,5	—	—	—	—	—	—	0,25	—	0,35	0,5
22	Sept. 1, ,,	5. 0.57 a.m.	1.45	8.43	4.41	13.24	11.33	7,5	4,4	{24,7 14,2	—	27,3	16,7	12,1	10,8	0,25	0,20	0,40	0,45	3,0	—	3,2	—	0,26	—
23	,, ,, ,,	6. 2.17 p.m.	0.50	—	—	3.15	12.54	8,5	4,2	—	—		{21,0 15,0	{9,6 4,8	10,1	0,24	0,35	—	—	1,1	1,2	—	—	—	0,5
29	,, 14, ,,	3. 2.10 a.m.	1. 0	8.26	10.26	18.52	10.34	—	5,7	24,6	6,9	25,0	19,0	—	—	—	—	—	0,2	0,2	0,3	—	—	—	—
33	,, 22, ,,	9.26.11 p.m.	3. 0	5.37	4.18	9.55	13.30	9,2	4,4	13,6	5,4	{16,2 14,8	22,0	13,3	{16,4 9,6	0,12	—	0,28	—	1,3	—	1,9	1,9	—	—
43	Oct. 10, ,,	7.35.39 a.m.	0.48	—	—	—	—	—	—	—	—	—	22,0	—	14,0	—	—	—	—	—	—	—	—	—	—
44	,, 12, ,,	1.45.38 a.m.	2.30	6. 0	3. 7	9. 7	10.44	8,4	{4,5 1,7	16,8	7,2	{37,5 25,0	21,0	7,3	9,3	0,2	0,2	0,5	0,5	—	—	0,8	0,75	—	—
47	,, 22, ,,	9. 2.42 a.m.	1. 7	—	—	9.52	8. 0	7,9	—	—	—	29,0	20,0	8,9	{10,9 16,5	—	—	—	—	0,15	0,14	0,3	0,15	—	—
58	Nov. 17, ,,	9.54.53 p.m.	2.30	4.15	2. 0	6.15	10.35	8,4	—	25,2	7,1	—	21,7	13,4	10,5	0,12	0,12	1,0	0,55	—	—	0,16	0,17	—	—
61	,, 22, ,,	8.20. 3 p.m.	1.13	—	—	6.30	—	—	—	—	—	—	—	12,0	9,8	—	—	—	—	—	—	—	0,06	—	—
69	Dec. 11, ,,	3.39.32 p.m.	1.18	9.54	9.10	19. 4	—	6,7	—	—	7,7	25,0	18,1	8,0	—	—	—	0,02	0,05	—	—	0,05	0,06	—	—
93	Feb. 28, 1899	11.48.55 a.m.	1.30	—	—	7. 0	23. 0	7,8	—	—	—	—	—	—	9,1	—	—	—	—	—	—	0,16	0,22	—	—
98	March 7, ,,	4.39.50 a.m.	1. 0	—	—	22.20	13. 0	—	—	—	—	—	—	8,7	8,0	—	—	—	—	—	—	0,06	0,06	—	—
107	,, 21, ,,	11.35.44 p.m.	0.44	—	—	4.13	9.46	7,8	—	—	—	25,4	—	8,3	8,2	—	—	—	—	—	—	0,36	0,28	—	—
126	April 16, ,,	11. 1.34 p.m.	1. 5	—	—	17.35	26. 0	8,4	—	—	—	—	—	9,0	8,5	—	—	—	—	—	—	[illegible]	0,05	—	—
127	,, 17, ,,	10.46.50 a.m.	1.57	9.17	9.38	18.55	29.26	6,8	—	—	8,0	29,0	17,5	9,2	8,9	0,04	0,08	0,07	0,07	0,14	0,14	—	—	—	—
133	May 2, ,,	11.36.47 p.m.	1. 0	—	—	5.31	16. 0	7,2	—	—	—	—	—	8,8	9,8	—	—	—	—	—	—	0,09	0,08	—	—
143	June 5, ,,	1.37.48 p.m.	2. 0	17.35	17.21	34.56	—	8,1	5,6	—	10,8	28,7	18,2	—	—	—	—	0,08	0,04	—	—	0,04	0,05	—	—
147	,, 14, ,,	8.27.46 p.m.	1.24	8.24	7.48	16. 7	—	—	4,9	—	7,8	27,0	17,7	—	—	—	—	—	—	—	—	0,04	0,05	—	—

* Same abbreviations are used in other Tables.

TABLE II.—[A] CONT.

No.	Date.	Time of occurrence.	Duration of: Total eqke.	Duration of: 1st P. T.	Duration of: 2nd P. T.	Duration of: P. T.	Duration of: P. P.	Average period in 1st P. T.: Slower waves.	1st P. T.: Quicker waves.	2nd P. T.: Slower waves.	2nd P. T.: Quicker waves.	P. P.: Initial phase.	P. P.: Slow-per. phase.	P. P.: Quick-per. phase.	E. P.	Max. range of motion in 1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	P. P. Initial ph. (EW)	Initial ph. (NS)	Slow-per. ph. (EW)	Slow-per. ph. (NS)	Quick-per. ph. (EW)	Quick-per. ph. (NS)
		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
162	July 12, 1899	11.56.26 p.m.	1.25	—	—	3.48	6.12	6,8	4,3	—	—	—	11,0	7,1	9,2	—	—	0,14	0,16	—	—	0,5	0,34	0,30	0,25
163	„ 14, „	9. 6. 3 p.m.	3. 0	2.48	4.59	7.47	8. 0	{15,0 7,1	—	12,5	6,0	{30,0 20,0	{32,0 15,0	9,4	9,4	—	—	—	—	—	—	6,6	3,2	—	—
165	„ 17, „	1.59.23 p.m.	2. 2	4.29	2. 8	6.37	—	—	4,6	—	6,5	—	20,0	13,3	10,7	—	—	—	0,05	—	—	—	—	0,15	0,06
169	„ 24, „	10.23.33 a.m.	1.45	—	—	3.10	21. 0	12,4	—	—	—	—	—	10,2	9,8	—	—	—	—	—	—	—	—	0,10	0,18
177	Aug. 4, „	1.50. 2 p.m.	2.19	6. 7	3.55	9.42	8.18	8,9	{5,6 2,6	13,5	6,3	32,0	37,0	—	9,1	0,4	0,46	2,2	1,04	1,7	—	—	—	—	1,9
186	„ 18, „	5.46.32 a.m.	1.10	8.20	16.40	25. 0	14. 0	8,3	—	—	8,8	—	—	13,7	11,8	—	—	0,05	0,05	—	—	—	—	0,85	0,85
188	„ 25, „	0.20. 7 a.m.	1.10	9.33	9.49	19.22	12.20	8,7	4,6	—	8,7	27,0	22,0	—	—	0,06	0,05	0,15	0,22	—	—	0,08	0,2	—	—
198	Sept. 4, „	9.31.59 a.m.	3. 0	7.36	9.38	17.14	22. 0	{18,0 7,9	3,5	{66,0 34,5 25,2	—	32,6	23,5	16,2	{16,2 10,5	0,25	—	5,6	—	—	—	15,2	—	4,8	—
196	„ 11, „	3.14.16 a.m.	3. 0	7.38	6.53	14.31	—	6,8	—	—	—	—	32,0	—	10,4	—	—	—	—	—	—	2,6	—	—	—
197	„ „ „	6.50.58 a.m.	4. 0	7.43	6.30	14.13	15. 0	9,3	4,3	27,0	—	41,0	24,0	—	9,8	—	—	—	—	—	—	—	—	—	—
200	„ 17, „	10. 1. 8 p.m.	2. 0	—	—	9.20	—	—	—	—	—	—	—	8,7	—	—	—	—	—	—	—	—	—	0,05	0,02
201	„ 20, „	11.24.27 a.m.	1.15	10.19	12. 0	22.19	21. 0	8,7	6,0	—	10,5	42,0	—	16,5	16,0	—	—	—	—	—	—	—	—	0,9	—
207	„ 30, „	2.11. 0 a.m.	2. 0	5.46	3.39	—	10. 0	8,9	3,6	—	8,4	38,0	20,0	—	—	—	—	—	—	5,4	—	—	—	—	—
210	Oct. 4, „	5.56.22 p.m.	1. 5	—	—	2. 0	10. 0	—	2,9	—	—	—	16,4	11,8	9,4	—	—	—	—	—	—	0,2	0,25	—	—
217	„ 14, „	0.38. 5 a.m.	1.39	4.23	4.12	—	13. 0	7,4	4,0	—	10,8	—	20,0	11,3	9,9	0,08	0,07	—	0,14	—	—	0,1	0,14	—	—
218	„ „ „	2.55.24 a.m.	2.15	4.36	4.30	9. 6	7.40	8,0	—	—	9,1	—	15,5	11,8	10,1	0,1	0,12	0,15	0,15	—	—	0,21	0,2	—	—
220	„ 19, „	6.28.59 p.m.	2. 0	6.20	4.23	10.43	15.50	9,0	5,1	—	9,1	38,5	26,3	15,4	10,1	0,2	0,25	0,38	0,65	0,93	—	1,75	—	—	—
222	„ 24, „	1. 3.29 p.m.	2.36	3.10	3.23	6.33	8.22	11,8	{6,9 3,1	—	7,8	—	30,0	7,6	9,9	0,08	0,07	0,16	0,22	—	—	0,75	—	—	—
231	Nov. 12, „	7.27.18 a.m.	1.10	—	—	3.45	10. 0	—	—	—	—	—	13,0	9,4	10,6	—	—	—	—	—	—	0,04	0,04	—	—
234	„ 23, „	6.52.39 p.m.	4. 0	—	—	3.32	60. 0	7,6	2,1	—	—	31,0	16,0	11,2	9,3	—	—	—	—	2,7	—	6,3	—	—	—
235	„ 24, „	7. 2. 1 p.m.	2. 0	4.51	4.21	9.12	22. 0	7,7	—	16,3	—	—	14,8	9,3	9,2	0,05	0,05	—	0,9	—	—	—	—	0,55	—

[B] Earthquakes whose durations were less than ½ h.

No.	Date.	Time of occurrence.	Duration of: Total eqke.	Duration of: 1st P. T.	Duration of: 2nd T. T.	Duration of: P. T.	Duration of: P. P.	Average period in: 1st P. T. Slower waves.	1st P. T. Quicker waves.	2nd P. T. Slower waves.	2nd P. T. Quicker waves.	P. P. Initial phase.	P. P. Slow-per. phase.	P. P. Quick-per. phase.	E. P.	Max. range of motion in: 1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	P. P. Initial ph. (EW)	P. P. Initial ph. (NS)	P. P. Slow-per. ph. (EW)	P. P. Slow-per. ph. (NS)	P. P. Quick-per. ph. (EW)	P. P. Quick-per. ph. (NS)
		h m s	m			m s	m s	s	s				s	s	s							mm	mm	mm	mm
24	Sept. 4, 1898	0.26.58 a.m.	36	—	—	7.40	7.50	9,6	4,2	—	—	—	13,9	9,5	9,5	—	—	—	—	—	—	0,1	0,15	—	—
35	" 25, "	9.22.46 p.m.	30	—	—	10.50	—	—	—	—	—	—	20,0	8,2	10,4	—	—	—	—	—	—	0,05	0,04	—	—
40	Oct. 1, "	1.29.12 a.m.	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
45	" 19, "	4.27.46 a.m.	39	—	—	8.26	—	—	—	—	—	—	—	{11,0 19,0	—	—	—	—	—	—	—	—	—	very small	0,7
48	" 22, "	10.35.53 p.m.	20	—	—	1.43	4.30	1,2	2,7	—	—	—	7,8	{7,4 3,8	5,6	—	—	—	—	—	—	—	—	0,08	0,0
50	Nov. 2, "	8.43.15 p.m.	17	—	—	6. 0	—	6,7	—	—	—	—	—	7,6	—	—	—	—	—	—	—	—	—	0,04	0,0
51	" 5, "	8.48.45 p.m.	15	—	—	?	—	—	—	—	—	—	18,0	—	—	—	—	—	—	—	—	—	—	very sma	
57	" 14, "	4. 5.23 p.m.	40	—	—	1.28	7. 0	5,9	2,3	—	—	—	—	8,1	8,1	—	—	—	—	—	—	—	—	0,24	0,1
64	" 30, "	7.31.18 a.m.	17	—	—	5.30	1.30	7,1	—	—	—	—	—	7,6	—	—	—	—	—	—	—	—	—	0,04	0,0
65	Dec. 1, "	9.53.53 p.m.	33	—	—	6.20	—	—	—	—	—	—	15,0	—	12,0	—	—	—	—	—	—	0,06	0,02	—	—
76	" 30, "	11.28.49 p.m.	13	—	—	0.32	6.30	(very quick)				—	7,6	3,0	5,8	—	—	—	—	—	—	0,34	0,8	0,4	0,3
82	Jan. 23, 1899	11. 9.57 a.m.	27	—	—	6.42	5.47	8,3	—	—	—	—	8,3	3,7	8,0	—	—	—	—	—	—	—	—	0,08	0,1
84	" 27, "	10.47.32 p.m.	7½	—	—	0.55	2.26	6,4	2,0	—	—	—	—	4,7	—	—	—	—	—	—	—	—	—	0,04	0,0
86	Feb. 1, "	2.52.43 p.m.	26	—	—	5.35	—	—	—	—	—	—	—	9,2	—	—	—	—	—	—	—	—	—	0,05	0,0
88	" 11, "	4.52. 3 p.m.	27	—	—	6.58	—	5,3	—	—	—	—	22,0	—	—	—	—	—	—	—	—	—	—	0,07	0,0
95	March 3, "	9.50. 2 a.m.	20	—	—	5.30	5.15	—	—	—	—	—	15,8	—	—	—	—	—	—	—	—	0,05	0,03	—	—
97	" 6, "	11.36. 8 p.m.	25	—	—	5.28	—	—	—	—	—	—	—	7,9	—	—	—	—	—	—	—	—	—	—	—
102	" 15, "	6. 9.14 a.m.	21	—	—	?	7.20	—	—	—	—	—	12,1	7,7	—	—	—	—	—	—	—	—	—	0,05	0,1
110	" 28, "	8.30.59 p.m.	28	—	—	6. 8	—	—	—	—	—	—	23,5	—	—	—	—	—	—	—	—	—	—	—	—
111	" " "	9.23.14 p.m.	28	—	—	10.30	—	4,3	—	—	—	—	20,0	7,4	—	—	—	—	—	—	—	—	—	0,05	0,0
113	" 24, "	0.29. 5 a.m.	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
130	April 28, "	0.15. 2 a.m.	8	—	—	2. 0	1.29	—	—	—	—	—	—	7,4	—	—	—	—	—	—	—	—	—	0,05	0,0
138	May 14, "	10.56.31 p.m.	24	—	—	4.30	—	—	—	—	—	—	17,9	5,6	—	—	—	—	—	—	—	0,05	0,05	—	—
139	" 15, "	9.57.53 p.m.	37	—	—	5.45	9. 0	6,4	—	—	—	—	—	8,7	—	—	—	—	—	—	—	—	—	0,08	0,04
140	" 18, "	4. 1.45 a.m.	30	—	—	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
141	" 26, "	11.38.28 p.m.	13	—	—	0.51	—	—	—	—	—	—	—	6,4	—	—	—	—	—	—	—	—	—	0,02	0,0
145	June 10, "	3.35.20 p.m.	33	—	—	5. 5	—	5,1	—	—	—	—	—	9,8	—	—	—	—	—	—	—	—	—	0,04	very small

TABLE II.—[B] CONT.

No.	Date.	Time of occurrence.	Duration of: Total eqke.	Duration of: 1st P. T.	Duration of: 2nd P. T.	Duration of: P. T.	Duration of: P. P.	Average period in: 1st P. T. Slower waves.	Average period in: 1st P. T. Quicker waves.	Average period in: 2nd P. T. Slower waves.	Average period in: 2nd P. T. Quicker waves.	Average period in: P. P. Initial phase.	Average period in: P. P. Slow-per. phase.	Average period in: P. P. Quick-per. phase.	Average period in: E. P.	Max. range of motion in: 1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	P. P. Initial ph. (EW)	P. P. Initial ph. (NS)	P. P. Slow-per. ph. (EW)	P. P. Slow-per. ph. (NS)	P. P. Quick-per. ph. (EW)	P. P. Quick-per. ph. (NS)
		h m s	m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
146	June 13, 1899	4.31.18 a.m.	26	—	—	1.25	18. 0	—	—	—	—	—	—	11,0	11,0	—	—	—	—	—	—	—	—	0,05	0,04
149	,, 16, ,,	2.49.10 p.m.	25	3.40	2.48	6.28	—	—	2,7	7,5	—	—	—	12,4	—	—	—	—	—	—	—	—	—	0,06	0,02
152	,, 19, ,,	9. 2.22 p.m.	31	—	—	3.38	—	5,0	—	—	—	—	—	7,9	—	—	—	—	—	—	—	—	—	0,04	0,03
153	,, 24, ,,	11.46. 3 a.m.	15	—	—	4.10	6. 0	—	—	—	—	—	—	7,3	—	—	—	—	—	—	—	—	—	small	
154	,, 25, ,,	1.12.28 a.m.	33	—	—	17.24	—	7,8	—	—	—	—	16,1	12,4	—	—	—	—	—	—	—	0,04	0,08	—	—
155	,, ,, ,,	2.25.42 a.m.	36	—	—	19,55	7.35	9,0	—	—	—	—	16,8	—	11,0	—	—	—	—	—	—	0,04	0,04	—	—
156	July 4, ,,	0.44.11 a.m.	24	—	—	3.44	3. 0	4,3	—	—	—	—	—	7,5	9,5	—	—	—	—	—	—	—	—	0,03	0,03
166	,, 17, ,,	7.48. 2 p.m.	29	—	—	3.40	—	—	—	—	—	—	17,4	—	—	—	—	—	—	—	—	—	—	0,02	0,02
168	,, 21, ,,	7.25.55 a.m.	18	—	—	1.28	—	—	3,0	—	—	—	—	4,2	6,3	—	—	—	—	—	—	—	—	—	0,07
171	,, 29, ,,	6.23.18 a.m.	20	—	—	?	—	7,8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,05	0,32
172	,, 30, ,,	4.44. 6 p.m.	41	—	—	?	—	7,0	—	—	—	—	14,0	—	—	—	—	—	—	—	—	—	—	—	0,02
173	,, 31, ,,	1.30.11 a.m.	22	—	—	?	—	—	—	—	—	—	—	7,7	8,0	—	—	—	—	—	—	—	—	0,04	0,02
185	Aug. 14, ,,	8.55.29 p.m.	6½	—	—	—	—	—	—	—	—	—	—	9,5	—	—	—	—	—	—	—	—	—	—	—
187	,, 21, ,,	1.11.44 a.m.	22	—	—	7.55	—	7,1	—	—	—	—	—	10,5	—	—	—	—	—	—	—	—	—	very small	0,03
189	,, 26, ,,	7. 7.11 a.m.	20	1. 3	1.13	2.16	3.46	—	—	—	2,6	—	10,9	9,0	7,2	—	—	—	—	—	—	0,2	0,12	—	—
190	,, ,, ,,	1.58.29 p.m.	20	1.11	1. 2	2.13	3.32	—	—	—	3,1	—	10,1	9,2	7,5	—	—	0,03	0,03	—	—	0,18	0,17	—	—
198	Sept. 11, ,,	8.44.35 p.m.	19	2. 5	1.36	3.41	3.48	9,2	3,9	9,6	3,7	—	—	9,1	7,6	—	—	0,08	—	—	—	—	—	0,16	0,10
202	,, 28, ,,	8.26.22 p.m.	24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
203	,, ,, ,,	11. 8.45 p.m.	28	—	—	7.30	—	—	—	—	—	—	22,0	—	—	—	—	—	—	—	—	very small	0,07	—	—
205	,, 28, ,,	3.58.14 p.m.	19	—	—	?	—	—	—	—	—	—	—	6,4	—	—	—	—	—	—	—	—	—	0,04	0,05
206	,, 29, ,,	8.40.28 p.m.	17	—	—	2. 0	4. 0	—	3,8	—	—	—	—	8,9	—	—	—	—	—	—	—	—	—	0,1	0,1
211	Oct. 5, ,,	5.24.49 a.m.	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,05	0,05
219	,, 7, ,,	5.32.59 p.m.	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
238	Dec. 4, ,,	9.32. 1 a.m.	40	—	—	4.25	—	—	—	—	—	—	—	8,8	—	—	—	—	—	—	—	—	—	0,05	[illegible]
243	,, 24, ,,	8.52.35 p.m.	10(?)	—	—	—	8. 0	—	—	—	—	—	15,8	—	—	—	—	—	—	—	—	—	—	?	[illegible]
244	,, 25, ,,	6. 3.45 a.m.	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
245	,, 29, ,,	3.34.52 a.m.	25	1. 7	1.31	2.38	4.44	—	—	—	3,8	—	—	5,9	—	—	—	0,14	0,14	—	—	—	—	[illegible]	[illegible]

TABLE III.—Earthquakes which originated off the Eastern coast of Hokkaido. (Group II).

No.	Date.	Time of occurrence.	Duration of: Total eqke.	Duration of: 1st P. T.	Duration of: 2nd P. T.	Duration of: P. T.	Duration of: P. P.	Average period in: 1st P. T. Slower waves.	Average period in: 1st P. T. Quicker-waves.	Average period in: 2nd P. T. Slower waves.	Average period in: 2nd P. T. Quicker-waves.	Average period in: P. P. Initial phase.	Average period in: P. P. Slow-per. phase.	Average period in: P. P. Quick-per. phase.	Average period in: E. P.	Max. range of motion in: 1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	P. P. Initial ph. (EW)	P. P. Initial ph. (NS)	P. P. Slow-per. ph. (EW)	P. P. Slow-per. ph. (NS)	P. P. Quick-per. ph. (EW)	P. P. Quick-per. ph. (NS)
		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
34	Sept. 24, 1898	9.14.42 a.m.	?	—	—	1.20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
42	Oct. 7, ,,	11. 1.36 a.m.	0.37	—	—	1.20	3.30	8,6	{4,0 1,3	—	—	—	9,0	5,6	4,9	—	—	—	—	—	—	—	—	0,03	0,04
136	May 8, 1899	0.28.54 p.m.	1.20	—	—	1.43	8.15	10,8	1,2	—	—	—	8,2	6,9	9,1	0,14	0,23	—	—	—	—	—	—	1,3	1,1
142	June 5, ,,	3.46.32 a.m.	0.25	—	—	2.20	—	9,3	—	—	—	—	7,0	3,8	—	—	—	—	—	—	—	—	—	0,1	0,1
160	July 11, ,,	7.15.44 a.m.	0.25	1. 4	1. 4	2. 8	4.30	—	—	5,6	2,0	22,0	6,9	3,8	8,4	—	—	0,07	0,05	—	—	—	—	0,25	0,22
161	,, ,, ,,	4.40. 7 p.m.	1.20	—	—	2.23	5.40	{10,7 4,3	2,4	—	—	—	9,5	6,0	8,8	—	—	—	—	—	—	—	—	3,3	2,9
164	,, 14, ,,	11.21. 0 a.m.	1.37	—	—	2.30	—	5,0	—	—	—	—	14,6	9,5	10,5	—	—	—	—	—	—	0,2	0,04	—	0,08
181	Aug. 10, ,,	4.59.51 a.m.	0.18	—	—	1.38	3.35	—	—	—	—	—	6,2	2,7	4,1	—	—	—	—	—	—	—	—	—	0,1
228	Nov. 10, ,,	8.58.25 p.m.	1. 0	1.28	2. 3	3.31	4.12	—	3,9	7,4	—	—	—	5,5	8,9	—	—	0,12	0,05	—	—	—	—	0,25	0,3
232	,, 18, ,,	4.23. 8 p.m.	0.33	2. 0	1.12	3.12	—	9,5	—	18,6	3,0	—	9,6	5,1	5,9	—	—	0,05	0,05	—	—	—	—	0,13	0,14

TABLE IV.—Earthquakes which originated off the North-Eastern coast of Honshiu. (Group III).

No.	Date.	Time of occurrence.	Total eqke.	1st P. T.	2nd P. T.	P. T.	P. P.	1st P. T. Slower waves.	1st P. T. Quicker-waves.	2nd P. T. Slower waves.	2nd P. T. Quicker-waves.	P. P. Initial phase.	P. P. Slow-per. phase.	P. P. Quick-per. phase.	E. P.	1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	Initial ph. (EW)	Initial ph. (NS)	Slow-per. ph. (EW)	Slow-per. ph. (NS)	Quick-per. ph. (EW)	Quick-per. ph. (NS)
		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
4	July 20, 1898	6.46.14 p.m.	0.14	—	—	0.31	—	—	—	—	—	—	7,7	3,2	{2,2 5,5	—	—	—	—	—	—	0,1	0,1	0,09	0,05
16	Aug. 21, ,,	0. 8.22 a.m.	0.45	0.56	1.24	2.20	—	8,0	1,1	10,5	—	—	15,0	7,6	7,9	—	—	0,16	0,14	—	—	0,2	0,4	—	—
17	,, ,, ,,	1.28.44 a.m.	0.15	—	—	0.54	—	—	1,4	—	—	—	17,2	{3,9 1,1	6,9	—	—	—	—	—	—	—	0,05	—	—
19	,, 23, ,,	8. 5.17 a.m.	0. 5	—	—	0.56	—	—	{1,1 3,3	—	—	—	—	4,6	4,2	—	—	—	—	—	—	—	—	0,04	0,04
30	Sept 15, ,,	7.18.37 p.m.	0.8¼	—	—	—	—	—	—	—	—	—	—	4,3	—	—	—	—	—	—	—	—	—	—	—
31	,, 16, ,,	4.48.32 a.m.	0.17	—	—	0.27	—	—	—	—	—	—	—	5,3	4,3	—	—	—	—	—	—	—	—	0,4	0,5
36	,, 26, ,,	10.27.44 a.m.	0.12	—	—	0.32	—	—	—	—	—	—	5,9	2,6	3,9	—	—	—	—	—	—	—	—	0,05	0,05
53	Nov. 7, ,,	2.56.47 a.m.	0.18	—	—	0.19	3.50	—	—	—	—	—	9,3	3,5	—	—	—	—	—	—	—	—	—	0,8	1,4
68	Dec. 7, ,,	9.12.50 a.m.	0.10	—	—	0.44	—	—	—	—	—	—	7,2	—	—	—	—	—	—	—	—	—	—	0,08	0,06
70	,, 13, ,,	1.34.48 a.m.	0.19	1.21	0.42	2. 3	5.30	6,8	—	—	2,5	—	7,8	3,5	5,8	—	—	—	—	—	—	—	—	0,35	0,3
71	,, 14, ,,	3.27.15 p.m.	0.1⅛	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,09	0,04
85	Feb. 1, 1899	1.34.55 a.m.	0.54	—	—	1.27	10.30	—	—	—	—	20,5	11,0	9,0	9,2	—	—	—	—	1,0	—	0,75	—	0,75	0,70
89	,, 13, ,,	4.29.18 a.m.	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
90	,, 20, ,,	3.37.58 a.m.	0. 5	0.28	0. 4	0.32	0.26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,08	0,06

TABLE IV.—(GROUP III). CONT.

No.	Date.	Time of occurrence.	Duration of: Total eqke.	Duration of: 1st P. T.	Duration of: 2nd P. T.	Duration of: P. T.	Duration of: P. P.	Average period in: 1st P. T. Slower waves.	1st P. T. Quicker-waves.	2nd P. T. Slower-waves.	2nd P. T. Quicker-waves.	P. P. Initial phase.	P. P. Slow-per. phase.	P. P. Quick-per. phase.	E. P.	Max. range of motion in: 1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	P. P. Initial ph. (EW)	P. P. Initial ph. (NS)	P. P. Slow-per. ph. (EW)	P. P. Slow-per. ph. (NS)	P. P. Quick-per. ph. (EW)	P. P. Quick-per. ph. (NS)
		h m s	h m	m s	m s	m	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
94	Feb. 28, 1899	11.16. 0 p.m.	0. 5	—	—	0.53	0.18	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	0,12	0,1
103	March 16, „	4.49.14 a.m.	0.27	—	—	1.36	7. 0	—	2,4	—	—	—	{8,7 6,4	3,3	7,0	—	—	—	—	—	—	—	—	0,28	0,24
105	„ 20, „	8.25.47 a.m.	0.21	1. 4	1.17	2.21	4.40	—	2,1	4,9	2,4	—	5,3	4,0	—	—	—	00,5	0,05	—	—	—	—	0,15	0,06
106	„ „ „	4.12.29 p.m.	0.16	—	—	0.32	4.30	—	—	—	—	—	—	3,8	—	—	—	—	—	—	—	—	—	0,15	0,12
108	„ 20, „	7.22.36 p.m.	0.23	—	—	0.34	4.30	—	—	—	—	—	6,7	{3,0 1,8	7,6	—	—	—	—	—	—	—	—	0,52	0,30
120	April 9, „	5.42.22 a.m.	0.18	0.30	1.30	2. 0	12. 0	—	—	—	3,3	—	9,0	6,9	—	—	—	—	—	—	—	—	—	0,1	—
122	„ 13, „	4.29.57 a.m.	0.2½	—	—	0.14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,12	0,05
125	„ 16, „	2.27.28 p.m.	0.17	—	—	0.23	4.40	—	—	—	—	—	3,0	1,7	3,5	—	—	—	—	—	—	—	—	0,2	0,1
128	„ 19, „	3.13. 6 p.m.	0.2¼	—	—	0. 9	—	—	—	—	—	—	—	—	1,6	—	—	—	—	—	—	—	—	0,04	0,02
148	June 15, „	3.49.41 p.m.	0.25	1.18	1.46	3. 4	6.15	—	3,0	—	2,7	—	7,8	3,6	9,2	—	—	—	—	—	—	—	—	0,25	0,2
150	„ 17, „	10. 9.35 a.m.	1.19	—	—	2.32	7. 0	7,2	2,9	—	—	—	8,9	5,5	7,4	—	—	—	—	—	—	—	—	0,58	0,58
151	„ 18, „	1.52.27 p.m.	0.24	1.43	1.12	2.55	3. 8	—	—	4,7	3,1	—	—	5,7	6,9	0,04	0,05	—	—	—	—	—	—	0,13	0,11
167	July 18, „	1.59. 0 a.m.	0.20	0.12	0.33	0.45	—	—	—	2,1	—	—	8,5	—	7,1	—	—	—	—	—	—	—	—	0,14	0,14
176	Aug. 3, „	6.52.57 p.m.	0.20	—	—	0.38	—	—	—	—	—	—	6,9	3,2	8,2	—	—	—	—	—	—	—	—	0,4	0,45
182	„ 13, „	2.26.17 p.m.	0. 7	—	—	0.15	—	—	—	—	—	—	—	—	3,0	—	—	—	—	—	—	—	—	0,06	0,05
184	„ 14, „	8.48.24 a.m.	0. 7	—	—	0.14	—	—	—	—	—	—	—	2,0	4,4	—	—	—	—	—	—	—	—	0,07	0,02
194	Sept. 9, „	9.46. a.m.	0.15	—	—	—	—	—	—	—	—	—	9,3	—	—	—	—	—	—	—	—	—	—	—	—
195	„ „ „	11. 0.34 a.m.	0.42	—	—	0.42	12. 0	8,4	—	—	—	22,0	—	8,6	8,4	—	—	—	—	0,6	—	—	—	0,9	—
199	„ 18, „	11. 6.56 p.m.	0.14	—	—	0.30	3.44	—	—	—	—	—	6,9	5,1	3,8	—	—	—	—	—	—	—	—	—	—
208	Oct. 1, „	11.55.22 a.m.	0.24	—	—	2.32	—	—	2,2	—	—	—	10,6	7,8	—	—	—	—	—	—	—	—	—	0,15	0,2
221	„ 21, „	10. 8. 9 p.m.	0. 8	—	—	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,07	0,06
223	„ 29, „	11.18.47 p.m.	0. 8	—	—	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,04	0,04
224	Nov. 3, „	1.39.21 p.m.	0.29	—	—	4.50	6. 6	7,5	4,3	—	—	—	—	7,4	—	—	—	—	—	—	—	—	—	0,13	0,05
226	„ 6, „	7.58.47 p.m.	0.20	—	—	2. 5	8. 0	10,0	2,8	—	—	—	7,1	4,8	—	—	—	—	—	—	—	—	—	0,05	0,05
229	„ 11, „	2.40.24 a.m.	1. 0	—	—	1.14	9. 0	—	3,9	—	—	—	{4,2 7,0	3,2	6,8	—	—	—	—	—	—	[illegible]	[illegible]	0,55	0,35
230	„ „ „	7.10. 0 a.m.	0.35	1.30	1.28	2.58	5.42	7,9	—	—	5,9	—	6,1	2,7	8,1	—	—	—	—	—	—	[illegible]	[illegible]	0,1[illegible]	[illegible]
239	Dec. 10, „	11.22.21 p.m.	1. 0	1. 9	1.25	2.34	—	8,1	3,8	18,0	—	—	4,9	3,0	3,3	—	—	—	—	—	—	[illegible]	[illegible]	[illegible]	[illegible]
240	„ 12, „	3.48.27 p.m.	0.16	—	—	0.35	—	—	—	—	—	—	7,8	—	—	—	—	—	—	—	—	[illegible]	[illegible]	[illegible]	[illegible]

TABLE V.—Earthquakes which originated off the coasts of the provinces of Hitachi and Iwaki.
(Group IV).

No.	Date.	Time of occurrence.	Duration of: Total eqke.	Duration of: P. T.	Duration of: P. P.	Average period: P. P.	Average period: E. P.	Max. range of motion. (EW)	Max. range of motion. (NS)
		h m s	m s	m s	m s	s	s	mm	mm
3	July 15, 1898	5.10.22 a.m.	6. 0	0.19	0.21	1,1	—	0,16	0,21
18	Aug. 22, „	11.31.53 p.m.	6.20	0.17	—	{1,0 3,0	—	0,05	0,04
20	„ 23, „	11.42.53 a.m.	3.24	—	—	—	2,0	—	—
21	„ „ „	11.47.17 a.m.	3. 0	0.17	0.49	3,6	3,3	0,04	0,04
32	Sept. 16, „	8.32.40 a.m.	12. 0	0.16	—	—	3,8	0,3	0,3
37	„ 27, „	10.19.52 a.m.	16. 0	0.58	—	—	5,7	0,04	0,02
39	„ 28, „	7.53.40 a.m.	9. 0	0.30	—	{0,8 2,2	3,8	very small	
63	Nov. 28, „	10.56.10 p.m.	—	—	—	—	—	„	
92	Feb. 22, 1899	8. 2.18 a.m.	16. 0	1st P.T. 13,4 s; 2nd P.T. 8,0	3.50	{6,7 3,8	{6,7 3,8	0,65	0,45
109	March 22, „	8.22. 2 p.m.	5. 0	—	—	—	—	very small	
115	„ 26, „	6.46.45 a.m.	15. 0	0.16	4. 0	{8,5 6,0 3,2	7,0	0,6	0,6
128	April 15, „	0.40.26 a.m.	7. 0	1. 2	—	{4,8 3,4	3,4	0,04	0,05
174	Aug. 1, „	9.39.57 a.m.	6. 0	0. 7	1. 5	—	—	0,15	0,18
175	„ 3, „	1.34.52 a.m.	10. 0	0.17	0.45	—	{5,0 2,8	0,18	0,14
178	„ 5, „	9.18.53 a.m.	8. 0	0.26	0.40	—	3,8	0,1	0,05
183	„ 13, „	8. 0. 2 p.m.	4. 0	0.15	—	—	—	—	0,07
204	Sept. 27, „	1.57.39 a.m.	4.30	0. 7	0.20	—	—	0,15	0,06
209	Oct. 3, „	6.28. 3 p.m.	6. 0	0. 6	—	—	3,3	0,04	0,03
215	„ 10, „	6.47.26 p.m.	3. 0	0.28	0.25	6,5	1,9	0,12	0,14
242	Dec. 20, „	10.46.29 a.m.	13. 0	0.24	—	1,5	4,1	0,17	0,44
246	„ 31, „	9.40.17 a.m.	3.30	?	—	—	—	—	0,3

TABLE VI.—Earthquakes which originated off the southern coast of Honshiu. (Group V).

No.	Date.	Time of occurrence.	Duration of Total eqke.	1st P. T.	2nd P. T.	P. T.	P. P.	Average period in 1st P. T. Slower waves.	1st P. T. Quicker-waves.	2nd P. T. Slower waves.	2nd P. T. Quicker-waves.	P. P. Initial phase.	P. P. Slow-per. phase.	P. P. Quick-per. phase.	E. P.	Max. range of motion in 1st P. T. (EW)	1st P. T. (NS)	2nd P. T. (EW)	2nd P. T. (NS)	P. P. Initial ph. (EW)	Initial ph. (NS)	Slow-per. ph. (EW)	Slow-per. ph. (NS)	Quick-per. ph. (EW)	Quick-per. ph. (NS)
		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
99	March 7, 1899	9.55.29 a.m.	1.30	—	—	0.46	6.44	—	—	—	—	17,8	33,0	{9,4 2,3	8,0	4,2	—	—	—	—	—	—	—	15,9	—
100	,, ,, ,,	3.42.50 p.m.	0. 9	0.24	0.57	1.21	—	—	—	6,4	2,6	—	7,0	2,6	—	—	—	—	—	—	—	—	—	0,09	0,07
119	April 6, ,,	3.30.13 a.m.	0.11	—	—	0.48	7.15	7,7	2,2	—	—	9,1	7,8	2,3	—	0,25	0,25	—	—	—	—	—	—	0,42	0,32

TABLE VII.—Earthquakes which originated in Kiushiu or off its eastern coast. (Group VI).

		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
12	Aug. 10, 1898	10. 0.50 p.m.	0.9½	—	—	0.22(?)	—	—	3,7	—	—	—	7,2	—	3,7	—	—	—	—	—	—	—	—	0,15	0,15
14	,, 12, ,,	3.38.42 a.m.	0.30	—	—	2. 2	—	—	3,7	—	—	—	7,0	3,7	7,6	—	—	—	—	—	—	—	—	0,4	0,2
66	Dec. 4, ,,	1.45.32 a.m.	1.19	—	—	1.38	9. 9	8,6	—	—	—	—	9,4	{8,1 5,5	7,8	—	—	—	—	—	—	0,55	1,0	0,7	0,55
112	March 24, 1899	1. 2.35 p.m.	1. 9	1. 7	0.44	1.51	15. 0	8,6	{3,7 2,7	—	—	—	{26,5 16,0	8,7	8,8	—	—	—	—	—	—	1,2	1,3	0,8	0,9
236	Nov. 25, ,,	3.45.24 a.m.	} 2.13	—	—	1.54	—	{ 8,2 33,3	—	—	—	35,4	{24,0 17,0	8,0	—	0,5	1,3	—	—	6,5	—	6,4	9,6	2,7	—
237	,, ,, ,,	3.58.48 a.m.		—	—	—	—					31,3	{28,0 17,6	—	9,4	—	—	—	—	2,9	—	3,6	—	—	—

TABLE VIII.—Earthquakes which originated in Central Japan. (Group VII).

		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
9	Aug. 1, 1898	2.12.21 p.m.	0. 6	—	—	0.54	1.25	—	—	—	—	—	7,6	2,1	—	—	—	—	—	—	—	—	—	0,9	0,5
56	Nov. 13, ,,	11.33. 3 a.m.	0.13	—	—	0.26	2.30	—	2,2	—	—	—	7,5	1,1	6,6	—	—	—	—	—	—	—	—	0,46	0,50
81	Jan. 22, 1898	8. 4. 3 a.m.	0.13	—	—	0.27	4.30	6,5	0,8	—	—	—	11,7	2,3	8,0	0,14	0,1	—	—	—	—	0,55	0,6	0,55	0,5
87	Feb. 6, ,,	4. 7.54 a.m.	0. 8	—	—	0.24	2. 3	—	—	—	—	—	7,9	—	{6,4 3,3	—	—	—	—	—	—	0,15	0,10	—	—
233	Nov. 21, ,,	6.56.29 p.m.	0.20	—	—	0.28	3.35	7,6	2,5	—	—	—	8,4	4,9	7,1	—	—	—	—	—	—	—	—	1,0	0,8

TABLE X.—Earthquakes of miscellaneous origins. (Group IX).

		h m s	h m	m s	m s	m s	m s	s	s	s	s	s	s	s	s	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
5	July 25, 1898	6.18. 2 a.m.	0.14	—	—	0.45	1.30	—	3,5	—	—	—	7,7	—	—	—	—	—	—	—	—	—	—	0,06	0,07
212	Oct. 7, 1899	0.59.38 a.m.	0.30	—	—	0.15	3.28	—	1,2	—	—	—	5,2	6,5	—	0,19	0,18	—	—	—	—	—	—	2,2	1,7
216	,, 11, ,,	2.17.20 p.m.	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
225	Nov. 2, ,,	0.34. 0 a.m.	0.20	—	—	—	2.30	—	—	—	—	—	14,4	3,5	8,4	—	—	—	—	—	—	—	—	3,2	—

[IX a] Loal earthquakes observed at several places. (Sub-group VIII a).

No.	Date.			Time of occurrence.	Duration of			Average period		Max. range of motion.	
					Total eqke.	P. T.	P. P.	P. P.	E. P.	(EW)	(NS)
				h m s	m s	m s	m	s	s	mm	mm
1	July	14,	1898	7. 3.59 p.m.	2.30	0. 8	0.20	—	1,9	0,15	0,15
7	,,	25,	,,	0.17. 4 p.m.	11. 0	0.11	0.57	1,2	{1,8 4,9	1,4	—
8	,,	27,	,,	2.35. 2 a.m.	10. 0	0.17	—	{12,0 2,4	3,4	0,09	0,07
10	Aug.	7,	,,	11. 2.56 p.m.	3. 0	0.14	0.25	1,4	1,2	0,2	0,15
13	,,	11,	,,	5.40.37 p.m.	—	—	—	—	—	—	—
25	Sept.	4,	,,	3.53.21 p.m.	1.45	0. 4	—	—	—	—	—
26	,,	5,	,,	4.47.35 p.m.	1.30	0. 7	—	0,8	—	0,13	0,06
27	,,	7,	,,	1. 6.38 p.m.	0.48	—	—	—	—	—	—
38	,,	28,	,,	1.40.49 a.m.	10. 0	0. 9	1.27	{0,63 2,0	{2,8 4,5	0,9	1,1
41	Oct.	6,	,,	4.52.22 a.m.	1.15	0. 6	—	—	15,0	small	
46	,,	20,	,,	3.15.46 p.m.	1.14	0. 8	0.15	0,49	0,6	0,02	0,02
49	,,	26,	,,	10.30.14 a.m.	2.44	0.16	—	—	—	0,07	0,06
54	Nov	12,	,,	2.42.40 a.m.	2. 0	0. 9	0.19	1,1	1,5	0,14	0,15
55	,,	,,	,,	9.42.25 a.m.	12. 0	0.10	0.34	2,8	{2,8 7,0	—	0,12
59	,,	20,	,,	3.42. 4 a.m.	1.30	0. 6	0. 7	—	1,0	0,10	0,07
62	,,	28,	,,	7. 2.34 a.m.	2.10	0. 9	0.30	—	{1,1 4,8	—	0,1
67	Dec.	5,	,,	0.47.58 a.m.	3. 0	0. 7	0.26	—	—	0,2	[illegible]
73	,,	25,	,,	0.46.56 a.m.	3. 0	0·10	0.35	—	—	—	[illegible]
77	Jan.	1,	1899	1.49.45 a.m.	2.30	0. 7	0.20	—	—	0,14	0,07
80	,,	14,	,,	11.30.42 a.m.	0.30	—	—	—	—	0,1	0,14
83	,,	23,	,,	2.55 39 p.m.	0.40	—	—	—	—	0,05	0,07
96	March	6,	,,	3.11.40 p.m.	6. 0	0.11	—	1,1	2,2	—	0,04
104	,,	16,	,,	3.54. p.m.	?	—	—	—	—	—	—
114	,,	24,	,,	6.39.40 p.m.	4.30	? 0. 9	—	2,4	—	0,15	[illegible]
117	April	2,	,,	11. 1. 7 p.m.	5.30	0. 6	0. 9	—	—	1,1	[illegible]

No.	Date.	Time of occurrence.	Duration of Total eqke	Duration of P. T.	Duration of P. P.	Average period P. P.	Average period E. P.	Max. range of motion. (EW)	Max. range of motion. (NS)
		h m s	m s	m s	m s	s	s	mm	mm
118	April 5, 1899	1. 0.53 p.m.	9. 0	0.20	1.33	{3,1 / 2,2	—	—	—
[illegible]	„ 15, „	7.25.30 p.m.	33. 0	0.13	7.30	{5,5 / 2,9	{7,8 / 3,9	1,7	1,6
[illegible]	„ 24, „	6.36.59 a.m.	5. 0	{1st P.T. 3,8 s / 2nd P.T. 6,7	0.40	—	1,4	0,2	0,05
133	May 2, „	1. 2.22 a.m.	6. 0	0.13	0.14	—	{3,7 / 1,9	0,15	0,15
134	„ 4, „	10.27.28 a.m.	1. 0	0. 6	—	—	—	0,04	0,02
155	„ 6, „	2. 8.34 p.m.	2. 0	0. 6	0.20	—	1,2	0,45	0,55
157	July 7, „	5.12.49 a.m.	5. 0	0. 9	0.20	—	2,2	0,42	0,4
158	„ „ „	6.32.16 a.m.	1. 0	0. 4	—	—	—	0,1	0,05
159	„ „ „	6.53.17 a.m.	8. 0	{1st P.T. 3,0 s / 2nd P.T. 7,5	—	—	—	0,95	0,7
170	„ 27, „	2. 1. 5 p.m.	8. 0	0. 9	0.15	—	—	0,24	0,24
179	Aug. 7, „	6.11.22 p.m.	5. 0	0. 7	0.30	—	—	0,22	0,2
180	„ 8, „	9.53.41 p.m.	5. 0	0. 9	0.20	—	—	0,15	0,05
192	Sept. 8, „	10. 7.54 p.m.	5. 0	0. 9	0.16	—	—	0,12	0,07
214	Oct. 10, „	6.17.54 a.m.	5. 0	0.10	0.17	—	1,8	0,22	0,16

[IX b] Local earthquakes observed in Tokyo and at one other place. (Sub-group VIII b).

No.	Date.	Time of occurrence.	Total eqke	P. T.	P. P.	P. P.	E. P.	(EW)	(NS)
		h m s	m s	m s	m s	s	s	mm	mm
23	Sept. 11, 1898	10. 8.32 p.m.	1. 7	0.16	—	—	—	0,08	0,08
60	Nov. 21, „	9. 5.53 a.m.	—	—	—	—	—	very small	
72	Dec. 19, „	0. 0.15 p.m.	1.10	0. 4	0.14	0,58	—	0,08	0,04
79	Jan. 8, 1899	1.12.21 a.m.	2.35	0. 8	—	—	0,68	0,02	0,02
121	April 11, „	10. 5.45 a.m.	1. 0	0.18	0. 5	—	—	0,16	—
129	„ 20, „	5. 0.31 p.m.	0.50	0. 9	0. 8	—	—	0,16	0,08
137	May 11, „	5.59.12 a.m.	6. 0	0. 8	0.20	—	7,2	0,05	0,01
144	June 10, „	10.36.56 p.m.	5. 0	0. 8	—	{8,8 / 8,0	—	0,06	0,07
[illegible]	Sept. 2, „	8.15.45 a.m.	9. 0	8.20	—	5,8	—	0,08	0,04
[illegible]	Oct. 10, „	1.12.48 a.m.	8. 0	?	—	6,0	5,1	0,05	0,04

[IX c] Local earthquakes observed in Tokyo.
(Sub-group VIII c).

No.	Date.			Time of occurrence.		Duration of Total eqke	Duration of P. T.	Duration of P. P.	Average period P. P.	Average period E. P.	Max. range of motion. (EW)	Max. range of motion. (NS)
				h m s		m s	m s	m s	s	s	mm	mm
6	July	25,	1898	6.37.57	a.m.	0.41	0. 6	—	9,4	—	0,06	0,08
15	Aug.	17,	,,	4.26.50	p.m.	1. 0	0. 7	—	1,5	—	0,12	0,04
52	Nov.	6,	,,	9. 0.50	a.m.	15. 0	0.42	2.20	4,8	4,5	0,06	0,06
74	Dec.	27,	,,	4.43.42	p.m.	0.42	0.10	—	—	—	0,08	0,08
75	,,	29,	,,	4.12.	a.m.	3. 0	0.20	—	—	2,5	0,04	0,02
78	Jan.	5,	1899	9. 1. 8	a.m.	0.50	0. 9	—	4,4	—	0, 1	0,15
91	Feb.	21,	,,	1.11. 5	a.m.	—	—	—	—	—	very small	
101	March	18,	,,	10.51.58	p.m.	0.30	0. 6	—	—	—	0,05	0,01
116	,,	29,	,,	11.42.14	p.m.	3.30	0.19	—	—	4,0	0,04	0,01
227	Nov.	7,	,,	4.48.50	p.m.	1.20	0. 8	—	—	—	0,08	0,10
241	Dec.	14,	,,	2.29.36	a.m.	2.30	0.15	—	—	—	—	—

III. Periods of Waves in Distant Earthquakes.

12. *Earthquake motion proceeding from distant origins.*—I shall here confine myself to the consideration of those distant earthquakes (Group I), whose durations varied between ¾ h and 4 hs. (See Table II [A]). The motion consists generally of several sets of waves of different periods superposed upon each other, but the successive epochs of each earthquake seems to have certain predominating periods of vibrations.

13. *The 1st preliminary tremor.*—In the 1st preliminary tremor, the motion consisted essentially of p_1'' type vibrations, superposed with p_1' type ones, the former having the average period nearly double that of the latter, as follows :—

p_1'' type. The average period, which varied between 6,7s and 12,4s, had a mean value of 8,03s.—In the two cases of eqkes Nos. 163 and 193, there were also slow undulations of periods respectively of 15,0 and 18,0s. These waves are probably of the same kind as those often occurring in the 2nd preliminary tremor.

p_1' type. The average period, which varied between 2,1s and 6,9s, had a mean value of 4,56s.—In the three cases of eqkes Nos. 44,177 and 222, there were also small quick vibrations, the mean value of whose average periods was 2,5s.

14. *The 2nd preliminary tremor.*—Here again the motion consisted essentially of vibrations, whose average period was exactly similar to that of p_1'' type in the 1st preliminary tremor and which may be termed as p_2' type waves.

p_2' type. The average period, which varied between 5,4s and 10,8s, had a mean value of 8,06s.—In only one case, eqke No. 2, were there also vibrations of an average period of 3,1s.

In 13 cases there were also traces of slow undulations, which may be distinguished as p_2'' p_2''' and p_2'''' type waves.

p_2'' type. The average period which varied between 12,5 and 16,8s, had a mean value of 14,5s.

p_2''' type. The average period, which varied between 24,6 and 27,0s, had a mean value of 25,3s.

p_2'''' type. The average period was 66s. The waves of this type occurred only in eqke No. 193.

In eqke No. 193, there were also waves of an average period of 34,5s.

15. *The principal portion.*—As may at once be remarked from the detailed analysis of the seismograms given in the next volume, the *principal portion* begins generally with a few very slow undulations, (the *initial phase*) which here shall be distinguished as p_3 type waves. Then follow in most cases, for a certain interval of time, a series of slow undulations (the *slow-period phase*), whose period is generally different from that of the p_3 type undulations, and which may be distinguished as p_4 type waves. These are again followed by comparatively quick-period waves (*the quick-period phase*), to be distinguished as p_5 type waves. The periods in the three successive epochs of the principal portion are as follows:—

p_3 type. The waves of this type may be subdivided according to the length of period into the three types of p_3' p_3'' and p_3'''.

p_3' type. The average period, which varied between 37,5s and 41,0s, had a mean value of 39,2s.

p_3'' type. The average period, which varied between 27,0s, and 32,6s, had a mean value of 29,4s.

p_3''' type. The average period, which varied between 23,7s and 25,4s, had a mean value of 24,8s.

In a single case, eqke No. 33, there were undulations of an average period from 14,3 to 16,2s. These may be regarded as being identical with the p_2'' type waves already considered.

p_4 type. The waves of this type may again be subdivided into three types of p_4' p_4'' and p_4''', according to the length of the period:—

p_4' type. The average period, which varied between 30s and 37s, had a mean value of 32,8s.

p_4'' type. The average period, which varied between 19s and 26,6s, had a mean value of 21,6s.

p_4''' type. The average period, which varied between 11,0s and 18,2s, had a mean value of 15,8s.

p_5 type. The waves of this type may be subdivided into two types of p_5' and p_5'', as follows :—

p_5' type. The average period which varied between 13,3s and 16,5s, had a mean value of 14,5s.

p_5'' type. The average period, which varied between 7,1s and 12,1s, had a mean value of 9,61s.

16. *The principal portion.* (cont.)—In the following Table, I give $y_{3,4}$ or the duration of the time interval between the beginning of the principal portion and the first appearance of the p_5 type waves, or the *quick-period phase*, in cases of 13 large earthquakes, together with y_1 or the duration of the 1st preliminary tremor, where these durations have definitely been measured.

No. of eqke.	y_1		$y_{3,4}$	
	m	s	m	s
69	9	54	6	0
127	9	17	7	41
143	17	35	22	0
147	8	24	29	50
186	8	20	5	58
188	9	30	8	55
193	7	36	8	30
201	10	19	12	0
217	4	23	2	41
218	4	36	8	19
220	6	20	5	0
222	3	10	2	48
58	4	15	4	34
Mean.	9	10	7	58

Thus we have, on average,

$$\frac{y_1}{y_{3,4}}=0,87$$

Thus y_1 is approximately equal to $y_{3,4}$ (See § 34).

The time interval between the beginning of the principal portion and the appearance of the *slow-period phase* was generally difficult to estimate definitely, there being often cases in which there existed no *initial phase*.

17. *The end portion.*—The motion, which is to be distinguished as p_6' type, consisted mostly of regular vibrations, whose average period varied between 8,0s and 10,9s and had a mean value of 9,75s.

In five cases of eqkes Nos. 33,43,47,193 and 201, there were also slower waves, to be distinguished as p_6'' type, whose average period varied between 14,0s and 16,5s and had a mean value of 15,8s.

18. *Results summarized.*—The results obtained in the preceding § § are summarized in the following table ; the periods, which may be regarded as mutually equal, being collected in the same horizontal row.

1st Prel. tr.	2nd Prel. tr.	Principal portion. Initial phase.	Principal portion. Slow-per. phase	Principal portion. Quick-Per. phase.	End portion.	Mean.
(p_1') 4,56	—	—	—	—	—	$P_1=4,56$
(p_1'') 8,03	(p_2') 8,06	—	—	(p_5'') 9,61	(p_6') 9,75	$P_2=8,86$
—	(p_2'') 14,5	—	(p_4''') 15,8	(p_5') 14,5	(p_6'') 15,8	$P_3=15,2$
—	—		(p_4'') 21,6	—	—	$P_4=21,6$
—	(p_2''') 25,3	(p_3''') 24,8	—	—	—	$P_5=25,1$
—	—	(p_3'') 29,4	(p_4') 32,8	—	—	$P_6=31,1$
—	—	(p_3') 39,2	—	—	—	$P_7=39,2$
—	(p_2'''') 66,0	—	—	—	—	$P_8=66,0$

P_1 P_2.....P_7 P_8 denote the means of the periods in the different rows. The figures in the above table may be regarded as representing the periods most likely to occur in the different epochs of distant earthquakes. There probably exist a series of periods between the

values of P_7 and P_8, which must be discovered by further observations. Some of the points to be noted are the following.

1.—p_1'' in the 1st preliminary tremor and p_2' in the 2nd preliminary tremor are identical, giving the mean value of 8,05s.

2.—p_5'' in the quick-period phase of the principal portion and p_6' in the end portion are identical, giving the mean result of 9,68s.

3.—p_2'' of the 2nd preliminary tremor, p_4''' and p_5' of the principal portion, and p_6'' of the end portion are identical.

4.—p_2''' of the 2nd preliminary tremor and p_3''' of the principal portion are identical.

5.—p_3'' and p_4' of the principal portion are identical.

The six periods P_1 P_2 P_3 P_4 P_5 and P_6 form roughly a series of an arithmetical progression, the mean common difference being 5,0s.

19. *The periods of vibration in the 1st and 2nd preliminary tremors and in the end portion.*—It will be observed that the periods of vibration in the 1st and 2nd preliminary tremors and in the end portion of different earthquakes are nearly constant, and further that their mean value, P_1, is nearly equal to the limiting value of 8,0s of the average period of *pulsatory oscillations.* This may probably be explained on the assumption that different portions of the earth's crust have particular periods of free oscillations, as discussed again in the case of *pulsatory oscillations* (§ 31). Such a supposition fits particularly well in the case of the vibrations in the end portion; since the duration of an earthquake is long and the ground must be executing wave motion for a considerable time interval after the original impetus, which caused the seismic disturbance, has ceased. This is quite analogous to the motion of sea waters, the diagrams from tide-

gauges showing constant periods proper to different places of observation.*

20. *Remarks on the period of the earthquake motion.*—The average period in distant earthquakes remains constant throughout the end portion. Within certain limits, the period of the different types P_1 P_2 ......P_8 may depend on the distance between the earthquake origin and the place of observation. This and other questions shall be discussed on another occasion, but in the meanwhile I may state that long-period undulations also exist in earthquakes of near origin. Thus, for instance, in the Kiushiu earthquakes, Nos. 236 and 237, the periods of 31,3 to 35,4s were recorded in Tokyo. Different kinds of waves are probably originated simultaneously at the seismic origin, but quick-period vibrations are soon dissipated in consequence of the viscosity of the material forming the earth's crust, while slow undulations are less subject to such a dissipation and travel to great distances.

IV. On the Nature of the Long-Period Undulations of Earthquakes.

21. About two years ago I expressed the view that the slow-period undulations of great earthquakes are probably *horizontal*, and not tilting, movements.† This supposition was based on the fact that, in the earthquake of Nov. 7th, 1898, the range of motion was equally large in the diagrams from two different horizontal pendulum apparatus, both in the E W direction, which ought to have been differently sensitive to the tilting of the ground, if any.

Recently I have observed a number of earthquakes simultaneous-

* See Vol. XXXIV of the Reports (Japanese) of the Earthquake Investigation Committee in which the present writer discusses in detail the tide gauge diagrams at different places in Japan, in reference to the causes of sea-waves.

† Journ. Coll. Sc. Imp. Univ. Tokyo, Vol. XI, 1899.

ly with the three horizontal pendulum apparatus A, B and C. (See § 7). A glance at their diagrams shows that the amplitude depends on the multiplication ratio of the writing pointer, and not on the sensibility of the pendulums to tiltings, in so far as the motion recorded is not confused by the proper oscillations of the heavy "steady mass" themselves. I shall next discuss, as an example of a seismic disturbance with very slow undulations, the diagrams of the earthquake of Oct. 29th, 1900.

22. *The earthquake of Oct. 29th, 1900; 6h 31m 52s.*

Total duration=4 h.

This was a very large earthquake at a great distance, and the ground continued more or less in a state of motion for several hours. The earthquake was satisfactorily recorded by the three horizontal pendulums A, B and C at Hongo as well as by the apparatus D at Hitotsubashi. The diagrams from the two pendulums C and D are reproduced in Pls. XII and XIII; *a* is the beginning of the earthquake; *ab* and *bc* are respectively the 1st and 2nd preliminary tremors; and *c* is the commencement of the principal portion.

The earlier part *cd* of the principal portion consists of very slow undulations, whose elements measured from the four diagrams are as follows :—

(1)

Hor. Pendulum A : EW component, Hongo;
- max. 2a=0, 26mm.,
- aver. period=45,5 s.

Hor. Pendulum B : NS component, Hongo;
- max. 2a=0,31 mm.,
- aver. period=41,8 s.

Hor. Pendulum C; EW component, Hongo;
- max. 2a=0,35 mm.,
- aver. period=45,3 s.

Hor. Pendulum D; EW component, Hitotsubashi;
- max 2a=0,36 mm.,
- aver. period=47,0 s.

Then follows the *quick-period phase*, whose elements are as follows :—

(2)

Hor. Pendulum A : EW component, Hongo;

$\begin{cases} \text{max } 2a = 1{,}15 \text{ mm.,} \\ \text{aver. period} = 31{,}0 \text{ s.} \end{cases}$

Hor. Pendulum B : NS component, Hongo;

$\begin{cases} \text{max. } 2a = 0{,}49 \text{ mm.,} \\ \text{aver. period} = 26{,}0 \text{ s.} \end{cases}$

Hor. Pendulum C : EW component, Hongo;

$\begin{cases} \text{max. } 2a = 1{,}15 \text{ mm.,} \\ \text{aver. period} = 31{,}0 \text{ s.} \end{cases}$

Hor. Pendulum D : EW component, Hitotsubashi;

$\begin{cases} \text{max. } 2a = 1{,}9 \text{ mm.,} \\ \text{aver. period} = 30{,}0 \text{ s.} \end{cases}$

In the above measurement, the ranges of motion, 2a, have been obtained on the assumption that they were horizontal movements, that is, by dividing the recorded movements by the multiplication ratio of each instrument. With respect to (1), where the average period was about 45½ s, the two EW component apparatus C and D thus gave practically identical results, while the apparatus A recorded a slightly smaller max 2a. Considering, however, the extreme length of the period, these three results may be regarded as being very near to each other; since, in cases like this, a slight difference in the amount of friction between the writing index and the record receiver may easily produce a sensible error.

With respect to (2), where the period was somewhat quicker and equal to 31 s, the two EW component apparatuses at Hongo, A and C, gave exactly identical results. The Hitotsubashi apparatus D gave a larger max. 2a, due probably to the proper period of the pendulum being very near to the period of the earthquake motion.

The periods of free oscillation of the three EW component horizontal pendulums at Hongo and Hitotsubashi, whose dimensions were already given in § 7, were in this case respectively 28,0 s, 60,0 s and 29,7 s. Let us denote by r_A r_C and r_D the angular displacements of the ground corresponding to 1 mm. motion of the writing indices of the three apparatus. We have then, by equation (1),

$$r_A = 0,'105$$
$$r_C = 0,0229$$
$$r_D = 0,112$$

Or if δ_A, δ_C and δ_D denote the displacements of the writing indices of the three instruments for the tilting of 1″, we have

$$\delta_A = 9,5 \text{ mm.}$$
$$\delta_C = 43,7 \text{ ,,}$$
$$\delta_D = 8,9 \text{ ,,}$$

Thus if the slow undulations under consideration had been due to the tilting of the ground, the apparatus C ought to give records of motion nearly 5 times larger than the apparatus A and D. Such, however, is very far from being the case.

23. Another point, which bears on the question of the nature of the slow earthquake undulations, was suggested to me by Dr. Charles Davison. This is the amount of the vertical amplitude which would exist according to the assumption that these slow movements are due to the tilting of the ground. As illustrative examples I shall take the severe Japan earthquake of Nov. 25th, 1899; the Java earthquake of Sept. 30th, 1899; the Alascan earthquake of Sept. 4th, 1899; and the Indian earthquake of June 12th, 1897. The first three of these earthquakes are respectively Nos. 236, 207 and 193 of our list (Table I).

(*a*). *The Japan earthquake of Nov. 25th, 1899.*—The origin was off the eastern coast of Kiushiu at a distance of 840 km. from Tokyo.

Here the record from the horizontal pendulum C (Pl. X) shows, in the principal portion, two main series of waves, (1) and (2), whose respective maximum traces were as follows :—

(1) range*=64,0 mm., period=24,0 s ;
(2) range*=27,0 mm., period=8,0 s.

In this case, the period of free oscillation of the pendulum was 2 m, so that the sensibility to tilting was very great, as follows :—

1 mm. displacement of the writing index=0,''0057. Hence the above maximum traces of (1) and (2), if due to the tilting of the ground, would respectively correspond to the angular movements of

$$\delta_1 = 64 \times 0,''0057 = 0,''365,$$
$$\text{and} \quad \delta_2 = 27 \times 0,0057 = 0,154.$$

If now the earth's surface be thrown, in consequence of the tilting into the form of a sine curve, each of the above δ's may be supposed to represent the greatest angle of inclination of the surface during the passage of the particular wave in question, and we have

$$2A_1 = \frac{\lambda_1 \delta_1}{\pi} = \frac{24 \times 3,3 \times \sin 0,''365}{\pi} = 10,6 \text{ mm.},$$

$$2A_2 = \frac{\lambda_2 \delta_2}{\pi} = \frac{8 \times 3,3 \times \sin 0,''154}{\pi} = 6,3 \text{ mm.}$$

where $2A_1$ and $2A_2$ are respectively the double vertical amplitudes of the two waves under consideration, whose wave-lengths are denoted by λ_1 and λ_2. In the above calculations the velocity of transit of the earthquake wave has been assumed to be 3,3 km. per sec. The maximum vertical accelerations would be respectively 1,4 and 1,9 mm. per sec. per. sec.

(*b*). *The Java earthquake of Sept. 30th, 1899.*—The record from

* These are the direct readings, not divided by the multiplication ratio of 10.

the horizontal pendulum A (Pl. VI) shows, at the commencement of the principal portion, the following large trace of motion :—

$$2a = 54{,}0 \text{ mm., period} = 38{,}0 \text{ s.}$$

In this case the period of oscillation of the horizontal pendulum was 28 s and 1 mm. displacement of the index corresponds to 0",105 (§ 22), so that the above displacement would, if due to tilting, amount to the angular motion of

$$\delta = 54 \times 0{,}''105 = 5{,}''7.$$

In this case we must take for the transit velocity the value of 4,8 km. per sec. (v_3 in the rotation of § 34), and we obtain, for the double vertical amplitude of the tilt wave,

$$2A = \frac{38 \times 4{,}8 \times \sin\ \delta}{\pi} = 1610 \text{ mm.}$$

This would give the maximum vertical acceleration of 22 mm. per sec. per sec.

(*c*). *The Alascan earthquake of Sept. 4th 1899.*—The record from the horizontal pendulum A (Pl. VII) shows, in the *quick-period phase* of the principal portion, a series of undulations of average period of 16,2s, whose maximum trace was 48,0 mm. The sensibility here was the same as in the preceding case, and therefore the corresponding tilting motion would be

$$\delta = 48 \times 0{,}''105 = 5{,}''04.$$

Taking the transit velocity to be equal to 3,3 km. per sec. (v_4 of §§ 34,38), the double vertical amplitude would be

$$2A = \frac{16{,}2 \times 3{,}3 \times \sin\ \delta}{\pi} = 416 \text{ mm.}$$

This gives the maximum vertical acceleration of 31,3 mm. per sec. per sec.

(*d*). *The Indian earthquake of June 12th, 1897.*—According to Prof. G. Agamennone, the period of large undulations as observed in Europe was about 20s, and the "maximum inclination" of the ground was 12″.* Taking here the velocity of transit to be the same as in the preceding case, namely 3,3 km. per sec., the double vertical amplitude would be

$$2A = \frac{20 \times 3{,}3 \times \sin 12''}{\pi} = 1220 \text{ mm.}$$

This gives the maximum vertical acceleration of 60 mm. per sec. per sec.

(*e*). *Summary.*—According to the calculations made above, it seems probable that in some cases, as with the Japan earthquake (a), the vertical movement of the supposed tilt wave amounts only to a few mm. or a few cm., with a corresponding maximum acceleration of only 1or 2 mm. per sec. per sec. Such a motion could not probably be felt by us. But in other cases, as with the earthquakes of Java, Alasca and India (b, c, d), the vertical displacement, consequent to the tilt wave, would be considerable, ranging in the examples treated of, from 416 to 1610 mm; their maximum accelerations are accordingly very large and vary between 22 and 60 mm. per sec. per sec. Movements like these would be sufficiently intense as to be felt by us, and indeed a motion with an acceleration of 50 to 60 mm. per sec. per sec., may be classed as a strong earthquake shock. By way of comparison, I reproduce here from the late Prof. S. Sekiya's work on the Tokyo earthquake measurement † the following elements of motion at Hitotsubashi :—

---

* G. Agamennone :—*Il terremoto dell' India del 12 giugno 1897, registrato in Europa.* Rendiconti della R. Accademia dei Lincei. Vol. VII. 1898.

† S. Sekiya :—*Earthquake measurements, etc.* Jour. Coll. Sc. Imp. Univ. Tokyo. Vol. II.

Max. horizontal motion ....0,73 mm.
Period of max. hor. motion............... 0,96 s.
Duration of hor. motion.................. 117 s.

These figures are the means deduced from 95 earthquakes observed with Prof. Ewing's seismograph at Hitotsubashi (Tokyo) during 1885—1887. From the above we see that the average maximum (horizontal) acceleration is

$$\frac{2\pi^2 \times 0{,}73}{0{,}96^2} = 15{,}6 \text{ mm. per sec. per sec.}$$

It may be remarked that earthquakes are felt always much stronger at Hitotsubashi than in other parts of Tokyo, and the value of the acceleration here deduced may therefore be taken as representing the intensity of motion of moderate strength. Thus it will be seen that the earthquakes of Java and Alasca observed in Tokyo, or the earthquake of India observed in Europe, ought to be felt as moderate or strong shocks, if their undulations be tiltings of the ground. Such, however, was certainly not the case. The conclusion is that the slow undulations of the earthquake motion can not, at least not generally, be ragarded as tilting movements.

24. As an illustrative example of sensible slow oscillations, I may take ship's rolling motion. On board a German steamer *Prinz Heinrich* (gross tonnage about 6,000 tons), I found the lateral oscillations had a period of about 15s. When the up-and-down range of motion at the edge of the upper deck was about 1m, the movements were of course there very well felt, the maximum acceleration in the vertical direction being about 88 mm. per sec. per sec.

25. Let us next see what are the maximum accelerations of the slow earthquake undulations, supposed to be horizontal movements. For three of the earthquakes discussed in § 23, observed in Tokyo, we have the following results.

(a). The Japan earthquake of Nov. 25th, 1899 :—
(Slower wave) Max. acc. = 0,22 mm. per sec. per sec.
(Quicker wave) Max. acc. = 0,83 „ „ „ „ „
(b). The Java earthquake of Sept. 30th, 1899 :—
Max. acc. = 0,074 mm. per sec. per sec.
(c). The Alascan earthquake of Sept. 4th, 1899 :—
Max. acc. = 0,36 mm. per sec. per sec.

The maximum horizontal acceleration in each of these cases amounts to a mere fraction of one mm. per sec. per sec., an amount much too small to be felt by us, or even to be registered by ordinary seismographs.

26. *Conclusion.*—From the discussions in the foregoing § §, it will be seen that there are several difficulties in attempting to explain the slow earthquake undulations as tilting movements, while there are none in supposing them to be horizontal movements. I conclude therefore that *the slow earthquake undulations are horizontal movements.*

It must here be noted that equation (1), which I have used for calculating the sensibility to the tilting of a horizontal pendulum is strictly applicable only when the period of the earthquake undulation is sufficiently long in comparison to the period of oscillation of the horizontal pendulum itself. The estimation of the amount of tilting in the cases like the Alascan earthquake (c) § 23, when the period of the earthquake movements was much shorter than that of the pendulum itself, is subject to a certain error. But this error causes the estimated amount of the tilting to be smaller than the actual value. Hence if properly corrected, the vertical displacement and its maximum acceleration would come out much greater than those given in § 23, which favours my argument still further.

27. With respect to ordinary *macro-seismic* movements, I have made at Hongo (Tokyo) a series of observations of earthquakes with

three sets of horizontal pendulum seismographs, whose sensibility to tilting and multiplication of horizontal motion were so arranged as to separate the horizontal motion from the tilting of the ground. The result so far obtained is that in the ordinary small and strong earthquakes, occurring so often in Tokyo, there is no tilting motion, or if any, not one sufficiently large to be recorded by means of ordinary seismographs.*

V. Pulsatory Oscillations.

28. *Pulsatory oscillations.*—Denote those small slow oscillations of the ground, whose origin is not seismic. Their average periods and ranges of motion in 70 cases between July 1898 and Dec. 1899 are collected in the following Table. These are not of course exhaustive, the measurements having only been made in so far as these movements occurred in the diagrams which contained earthquakes.

* A detailed account of these observations is given by the present Author in Vol XXXII of the Reports (Japanese) of the Earthquake Investigation Committee.

TABLE XI.—AVERAGE PERIOD OF PULSATORY OSCILLATIONS.*

1898.

Day. \ Month.	VII.	VIII.	IX.	X.	XI.	XII.
	s	s	s	s	s	s
1			5,3			
2						
3						
4			3,9			
5						
6			5,8			
7					4,2	6,7
8						
9						
10						
11						
12						
13						3,9
14				6,8	5,6	
15					4,5	
16						
17						
18						
19						
20						
21						
22						
23						
24						
25	4,8					
26						
27						4,0
28					4,2	
29						
30						
31						4,4

* The max. range of motion was in each component 0,16 mm.

TABLE XI.—Cont.

1899.

Month. / Day.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
	s	s	s	s	s	s	s	s	s	s	s	s
1												
2									3,6			
3			4,5						4,4			
4					3,6					6,4		
5								6,6		6,9		
6		4,5	7,7							7,2	4,8	
7			6,4				6,2	5,1		7,5		
8										8,0		
9				3,7						4,5		
10						4,3						
11		7,8					5,1		4,6			
12		3,9										
13			7,2									
14	4,8											3,9
15			3,8	3,7								
16			5,3									
17			4,0									
18				5,0				4,2				
19												
20		5,8										
21	3,9								5,7		3,9	
22	4,2	7,3										
23				4,0					8,0			
24			4,3	3,6								
25			4,9				3,9					
26			7,3									
27	4,1											
28									3,4			4,3
29							3,8			4,6		
30												7,7
31												5,0

It will be seen from the above table that the average period of the pulsatory oscillations varied between 3,4 s and 8,0 s; periods of 3,9 s to 4,5 s occurring most frequently. The frequencies of the several periods are diagramatically shown in the accompanying figure.

Diagram showing the frequency of the different periods of pulsatory oscillations.

29. The max. 2a of the pulsatory oscillations within the time interval in question was 0,16 mm. in each component, which occurred on Oct. 7th, 1899, the average period being 8,0 s. The EW component diagram for Oct. 6th–7th is given in Pl. XIV. The pulsatory oscillations were in this case doubtless caused by disturbances in the atmosphere, which occasioned the remarkable sea-waves on the after-noon of the 7th along almost the whole coast of the Japanese Islands. It is, however, to be noted that pulsatory oscillations were already very strong on the 6th, although on that day it was almost perfectly calm over Shikoku and the Main Island. The lowest barometric pressure was 714,5 mm., observed at Nagatsuro (province of Izu) on the 7th at 2 p.m. The weather map of Oct. 6th-7th is given in Pl. XVIII.

30. The most remarkable storm of pulsatory oscillations which I have so far observed occurred on Nov. 17th–18th, 1900, the max. 2a having reached 0,65 mm. in each component. The average period was 6,8s. The EW component diagram is given in Pl. XV

This storm of pulsatory oscillations was also evidently caused by disturbances in the atmosphere, strong winds having prevailed on the

17th over the whole country. The barometric depression was, however, in this case not very deep, the lowest reading being 743 mm. observed at Shiomi-saki (southern extremity of the province of Kii) on the 17th, 2 p.m. The weather chart is given in Pl. XIX.

31. *On the nature of the pulsatory oscillations.*—The pulsatory oscillations, which are in no essential way different from the vibrations constituting the 1st preliminary tremor and the end portion of a distant earthquake, seem to be horizontal movements and not tiltings of the ground. For the considerations bearing on this point the reader is referred to my paper on horizontal pendulums published in Vol. XI. of the Jour. Coll. Sc. Imp. Univ. Tokyo. The chief characteristic points of these movements, as observed in Tokyo, are the following:—

1. Pulsatory oscillations occur more frequently in winter than in summer.

2. Pulsatory oscillations continue generally for several days, there being no dependence of the frequency on the time of day.

3. The average period remains generally constant for several hours, not depending much on the amplitude.

4. The average period varies but little, the least value being 3,4 s. and the greatest value 8,0 s.

5. The direction of motion changes constantly, and each horizontal component shows a series of alternations of maximum and minimum groups; the motion is always on the whole equal in the two horizontal components. As additional illustrations, I give in Pls. XVI and XVII the EW component diagrams of the pulsatory oscillations on Nov. 18th–19th, 1900; the average period being 6,8s and the max. 2a being 0,25 mm. in each component.

The wave-length of pulsatory oscillations.—The wave-length of

pulsatory oscillations seems to be much longer than those of the quick-period vibrations of an earthquake which constitute the ordinary seismic shocks and which are most efficient in producing damage, as may be inferred from the comparison of the observations at the Seismological Institute in the Imperial University, Hongo, and at the Seismological Observatory at Hitotsubashi. The distance between the two places is only 2,29 km.

At Hongo the ground is high and consists of hard clay, while at Hitotsubashi it is low and very soft, and consequently the amplitude of earthquake motion, as registered by ordinary seismographs is two or three times greater at the latter place than at the former.* In fact it is well known that earthquakes cause very much greater damage in low soft country than on a hill or hard high ground. With respect to pulsatory oscillations, however, no such peculiarity is found, the amplitude and the period being always the same at Hongo and Hitotsubashi. This fact can only be explained by supposing the wave-length of the pulsatory oscillations to be comparatively very great. If we assume the velocity of transit of pulsatory oscillations to be the same as that of the ordinary surface transit of earthquake motion, namely, 3,3 km. per sec., the wave-length of pulsatory oscillations would vary between

$$3{,}4^{s} \times 3{,}3^{km} = 11{,}2 \text{ km.}$$
$$\text{and} \quad 8{,}0 \times 3{,}3 = 26{,}4 \quad ,,$$

Pl. XVII gives the Hitotsubashi EW component diagram of the pulsatory oscillations on Nov. 18th–19th, 1900. The motion will be seen to be equal to the corresponding Hongo diagrams given in Pl. XVI. (The multiplication of the Hitotsubashi instrument is 8,2, while that of the Hongo instrument is 10).

* See the late prof. S. Sekiya's paper on the earthquake measurement in Tokyo. Jour. Sc. Coll. Imp. Univ. Tokyo. Vol. II.

Relation of pulsatory oscillations and the formation of the ground.—As stated above, the phenomena of pulsatory oscillations do not seem to vary within a small area, such as Tokyo. When considered, however, with respect to widely distant localities, there is great difference in the frequency as well as the intensity of these movements. Thus in Tokyo, pulsatory oscillations occur very often and have not seldom quite large amplitude. On the other hand, the simultaneous horizontal pendulum observations at Miyako Meteorological Observatory (in the province of Rikuchu), Arima (in the province of Settsu), and the Kyoto Imperial University show very few and very slight traces of pulsatory oscillations. I may here remark that Tokyo lies on the extensive Musashi plain, but the three above named stations are situated respectively on a small promontary of a paleozoic formation, among granite mountains, and in a valley surrounded by granite mountains.

The period of pulsatory oscillations.—Since the period of pulsatory oscillations varies little, and especially since the period (average) remains generally constant for several successive hours, it may be supposed that these movements represent the proper vibrations of certain portions of the earth's crust, such as the plain of Musashi. In fact there is no reason to suppose that the ground, even when not disturbed by earthquakes, is perfectly at rest. On the contrary it would be more general to assume that the different portions of the earth's crust are continually executing greater or less movements of some sort; and, if so, the periods ought to be determinable in each case from the geotectonic circumstances of the ground.

I. On the Preliminary Tremors and the Velocities of Transit of the Earthquake Motion.

32. *The durations of the preliminary tremors.*—Let us first inquire about the relation that may exist between the durations of the 1st and 2nd preliminary tremors. From Tables II, III, IV, VI and VII, it will be seen that in general these two durations are not much different from one another; the duration of the 1st preliminary tremor varying in the cases of the distant earthquakes (Group I) between 1 m 11 s and 17 m 35 s, and that of the 2nd preliminary tremor between 1 m 2 s and 16 m 40 s. Confining our attention to the earthquakes of Group I (Table II), there are 28 cases in which the durations of the two preliminary tremors were definitely measured, as tabulated below.

TABLE XII.—DURATIONS OF THE 1ST AND 2ND PRELIMINARY TREMORS.
(Distant earthquakes, Group I.)

No. of eqke.	Duration of the 1st P. T.		Duration of the 2nd P. T.	
2	7^m	21^s	7^m	14^s
22	8	43	4	41
29	8	26	10	26
33	5	37	4	18
44	6	0	3	7
58	4	15	2	0
69	9	54	9	10
127	9	17	9	38
143	17	35	17	21
147	8	24	7	43
149	3	40	2	48
163	2	48	4	59
165	4	29	2	8
177	6	7	3	35
186	8	20	16	40
188	9	33	9	49
190	1	11	1	2
193	7	36	9	38
196	7	38	6	53
197	7	43	6	30
198	2	5	1	36
201	10	19	12	0
207	5	46	3	39
217	4	23	4	12
218	4	36	4	30
220	6	20	4	23
222	3	10	3	28
235	4	51	4	21

Taking means of these 28 case. we find :—

the mean duration of the 1st P. T.$=y_1'=6$ m 39 s.

„ „ „ „ „ 2nd P. T.$=y_2'=6$ m 21 s.

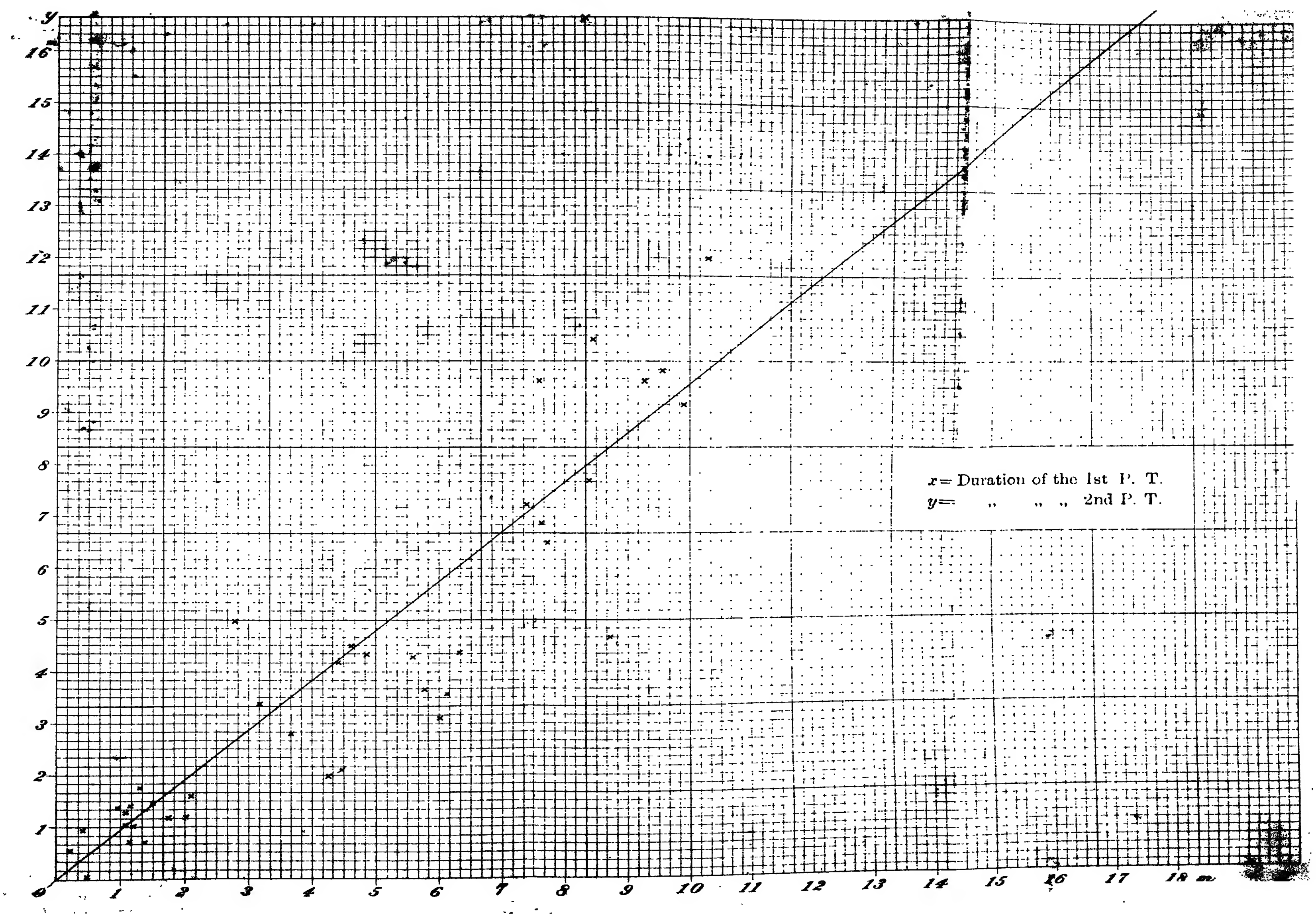
$$\text{Consequently} \quad \frac{y_1'}{y_2'}=1{,}05 \qquad (2)$$

Equation (2) gives the relation of the durations of the two preliminary tremors of distant earthquakes. Turning now our attention to the earthquakes of comparatively near origin, namely those of Groups II, III, V and VI,* we find 13 cases in which the durations of the 1st and 2nd preliminary tremors were distinctly measured, as follows :—

TABLE XIII.—Durations of the 1st and 2nd Preliminary Tremors.
(Earthquakes of near origins.)

Group.	No.	Duration of the 1st P. T.		Duration of the 2nd P. T.	
II.	160	1^m	4^s	1^m	4^s
	232	2	0	1	12
III.	16	0	56	1	24
	70	1	21	0	42
	90	0	28	0	4
	105	1	4	1	17
	148	1	18	1	46
	151	1	43	1	12
	167	0	12	0	33
	230	1	30	1	28
	239	1	9	1	25
V.	100		24	0	57
VI.	112	1	7	0	44

* In the earthquakes of the remaining Groups IV, VII, VIII and IX, the 1st and 2nd preliminary tremors were not generally separately distinguishable.


x = Duration of the 1st P. T.
y = ,, ,, ,, 2nd P. T.
y
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18 m

Taking means of the above 13 cases, we find :—

the mean duration of the 1st P. T. $= y_1' = 1$ m 6 s.

" " " " " 2nd P. T. $= y_2' = 1$ m 4 s.

$$\text{Consequently} \quad \frac{y_1'}{y_2'} = 1{,}04 \qquad (3)$$

Thus the ratio of the durations of the 1st and 2nd preliminary tremors is found to be the same for the distant earthquakes as well as for those of near origins. I shall therefore put generally

$$\frac{y_1}{y_2} = 1{,}05 \text{ ; or } y_2 = 0{,}95 \times y_1 \qquad (4)$$

in which y_1 denotes the duration of the 1st preliminary tremor and y_2 that of the 2nd preliminary tremor, of any given earthquake. Equation (4) shows that the durations of the two preliminary tremors are approximately equal to one another. (See § 34).

The accompanying figure illustrates the relation of the two preliminary tremors for the 41 earthquakes contained in the above two Tables ; the mean curve being the straight line *op* bisecting the angle between the axes of x and y.

33. *The relation between the duration of the 1st preliminary tremor and the distance of the earthquake origin.*—In Vol. XI of the Jour. Coll. Sc. Imp. Univ. Tokyo, I have discussed the relation between the duration of the *preliminary tremor* and the distance of the earthquake origin, for the cases in which the latter quantity was under 1000 km. and above 100 km. I propose now to investigate similar relations with respect to distant earthquakes. The reason why I take here the 1st preliminary tremor, instead of the 2nd preliminary tremor or the total preliminary tremor, is that the duration of the 1st preliminary tremor can generally be determined much more accurately than either of the two others.

As already pointed out by several seismologists, the durations of the *preliminary tremor* of an earthquake increases with the distance of the origin. I give in the next table the durations of the 1st preliminary tremor ($=y_1$) and the distance between the earthquake origin and the place of observation measured along a great circle of the earth ($=x$), for the Tokyo observations of the great earthquakes of Alasca, Smyrna and of Java, which all took place in Sept., 1899, as well as for some large Japanese earthquakes observed in Europe.

TABLE XIV.—RELATION OF THE DURATION OF THE 1ST PRELIMINARY TREMOR AND THE DISTANCE OF THE EARTHQUAKE ORIGIN.

No.	Earthquake.	Date	Place of Observation.	y_1 = duration of the 1st P. T.		x = distance (along the great circle) between the origin and place of observation.
a	Alascan eqkes.	Sept. 4th and 11th, 1899.	Tokyo	7 m	39 s	6100 km.
b	Smyrna eqke.	Sept. 20th, 1899.	„	5	46	4800
c	Java „	„ 30th, „	„	10	19	9200
d	Japan „	Feb. 20th, 1897.	Potsdam.	9	55	8990
e	Japan eqkes.	———	Italy.	10	36	9580

In the above table, *a* denotes the three Alascan earthquakes of Sept. 4th and 11th, 1899 (Nos. 193, 196 and 197, of Group I); the y_1 is the mean duration of their 1st preliminary tremors and the x the distance deduced by assuming their origins to be situated all off Cape St. Elias, at about lat. 60° N and long. 140° W. *b* is the Smyrna earthquake (No. 201, Group I) and *c* the Java earthquake (No. 207, Group I); their distances y_1 have been calculated by assuming their origins to be situated respectively near Aidin, in Asia Minor, lat. 37° 50′ N and long. 29° E, and off the southern coast of the Island of Cerang at about lat. 6° S and long. 129° E. *d* is the strong Japanese

earthquake of Feb. 20th, 1897, (origin lat. 38° 30′ N, long. 143° 30′ E), which caused some damage in the vicinity of the city of Sendai in the north-eastern part of Main Island (Honshiu); this earthquake was observed in Potsdam by the present writer by means of a new Paschwitz horizontal pendulum apparatus, with a quick rate of the photographic paper of about 300 mm. per hour. *e* denotes the nine destructive or strong Japanese earthquakes given in § 37, observed in Italy; y is the mean duration of the 1st preliminary tremors and x is the mean of all the distances between the earthquake origins and the places of observations, namely, Padova, Ischia, Rocca di papa, Rome, Verona, Pavia, Catania and Siena.

A glance at the table given above shows that y is nearly proportional to x. Let us therefore assume the following linear equation

$$ky+h=x, \tag{5}$$

where k and h are constants. Determining the values of these two quantities from the data given in the same table by means of the method of Least Squares, we obtain

$$17{,}1y_1-1360=x, \tag{6}$$

where y_1 is expressed in seconds and x in km. This equation, which is to be used strictly only for the cases of y_1 lying between about 5 m and 11 m, is fairly satisfactory, as will be seen from the 3rd and 4th columns of the following Table.

TABLE XV.—ESTIMATION OF THE DISTANCE OF THE EARTHQUAKE ORIGIN FROM THE DURATION OF THE 1st PRELIMINARY TREMOR.

No.	y_1		x (actual.)	x, calculated by equation (6)	x, calculated by equation (8)
a	7^m	39^s	6100 km.	6500 km.	6750 km.
b	5	46	4800	4560	5100
c	10	19	9200	9240	9090
d	9	55	8990	8840	8750
e	10	36	9580	9540	9360

As an illustration, let us apply equation (6) to the Sumatra earthquake of January 6th, 1900, whose origin was, according to Prof. E. Rudolph, at about lat. 3° 10′ S. and long. 102° 44′ E. The duration of the 1st preliminary tremor in Tokyo was 7m 24s, which gives, according to equation (6), 6240 km. for the distance between the earthquake origin and Tokyo, being not much different from the actual distance of 5,800 km.

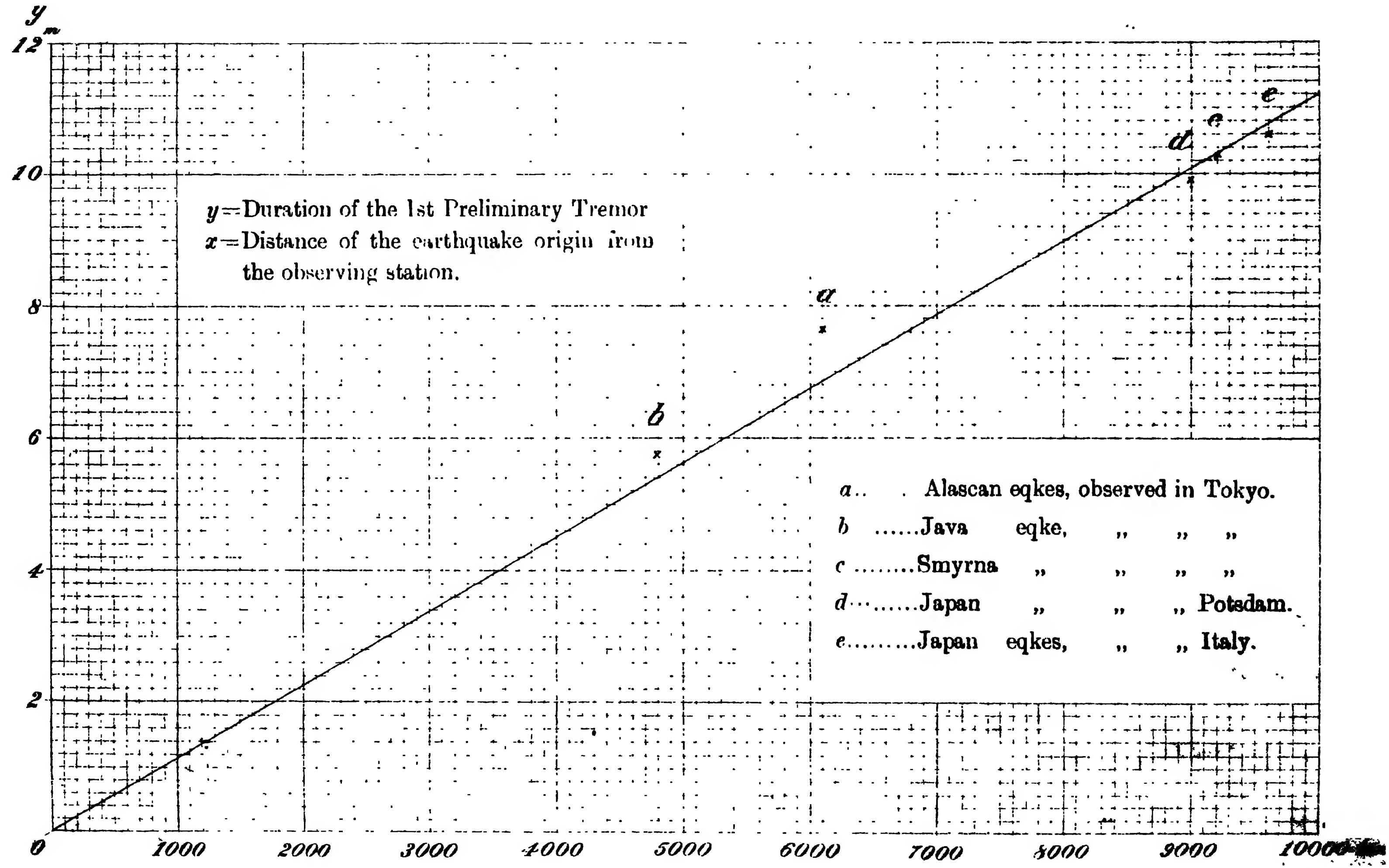
Instead of equation (5), we may, without much error, assume the following form of the relation between x and y_1 :

$$ky_1 = x \quad\quad\quad\quad (7)$$

where k is a constant. From the data in Table XIV, k is found to be 14,7, or

$$14{,}7\, y_1 = x, \quad\quad\quad\quad (8)$$

y_1 and x being expressed in the same units as in equation (6). Equation (8) gives also fairly good results, as shown in the last column of Table XV and has, besides being simpler, the advantage of being applicable even to earthquakes of near origin. As illustrations, I shall choose the Kiushiu earthquakes, Group VI. (See Table VII). Among the six earthquakes of this group, eqke No. 112 showed distinctly the 1st preliminary tremor, whose duration was 1m 7s. According to equation (8), this gives 980 km. for the distance between Tokyo and the earthquake origin, being not much different from the actual distance of 830 km.—With respect to the Kiushiu earthquakes, we may proceed more exactly as follows. The duration of the (total) preliminary tremor was definitely measured in the cases of the four earthquakes Nos. 14,66,112 and 236, the mean value being 1m 51s. Now according to equation (4) the durations of the 1st and 2nd preliminary tremors ought to be very nearly identical to one another. Hence we may infer from the above that the mean duration of the 1st


y
m
12
10
8
6
4
2
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
y=Duration of the 1st Preliminary Tremor
x=Distance of the earthquake origin from the observing station.
a
b
c
d
e
a.. . Alascan eqkes, observed in Tokyo.
b ......Java eqke, ,, ,, ,,
c ....Smyrna ,, ,, ,, ,,
d.........Japan ,, ,, ,, Potsdam.
e.........Japan eqkes, ,, ,, Italy.

preliminary tremor for the Kiushiu earthquakes to be $\frac{1}{2}\times$ (1m 51s)= 56s, which gives according to equation (8) 820 km for the mean of the distances between the earthquake origins and Tokyo. Actually the distances in question for the four earthquakes were respectively 900,830,820 and 840 km; their mean, namely, 850 km, being very near to the value given by equation (8).

The relation between x and y_1, as contained in Table XIV, is graphically illustrated in the accompanying figure, the line *op* being drawn according to equation (8).

34. *Relation of the duration of the 1st preliminary tremor of distant earthquakes to that of the preliminary tremor of earthquakes of near origin.*— For earthquakes of near origin the relation between the duration of the *preliminary tremor* ($=y$) and the distance between the earthquake origin and the place of observation ($=x$), referred to at the commencement of § 33, is expressed by the following equation:—

$$7{,}51\,y=x-24{,}9 \qquad \text{(9)}$$

y being expressed in seconds and x in km.

Equation (9) was deduced from the observations in Tokyo of several Japanese earthquakes, whose x varied between 70 and 900 km. and ought consequently to be used only within the corresponding limits of y. It will, however, be seen that equation (9) is in reality approximately identical with equation (8). For, when the distance x is great the constant term in (9) may be neglected and we have

$$7{,}51\,y=x \qquad \text{(9')}$$

Here y denotes the duration of the entire *preliminary tremor*, which comprises the 1st and 2nd preliminary tremors. On the other hand, equation (8) may be written, by virtue of equation (4), approximately as follows:—

$$14{,}7 \times \frac{y}{2} = x,$$

or $$7{,}35\ y = x, \qquad \ldots\ldots\ldots\ldots \ldots\ldots\ldots\ldots (8')$$

y being the duration of the total preliminary tremor. Equation (8′) is practically identical with equation (9′). Hence I conclude that the relation between the preliminary tremor and the distance of the earthquake origin is essentially the same both for earthquakes of distant origin and for those of near origin. Taking the mean of the coefficients of y in equations (8′) and (9′) and introducing again the constant term of 24,9, we obtain

$$\left.\begin{array}{l} 7{,}43\ y = x - 24{,}9 \\ 14{,}9\ y_1 = x - 24{,}9 \end{array}\right\} \qquad \ldots\ldots \ldots\ldots\ldots (10)$$

or

The applicability of these equations is limited, till further investigations are made, by the following condition

$$100 \text{ km} < x < 10000 \text{ km},$$

or $$10 \text{ s} < y < \text{about } 11 \text{ m}.$$

34. *The velocities of transit of earthquake motion proceeding from distant origin.*—In the description of the seismograms, the complete earthquake motion was divided into four main divisions of the 1st preliminary tremor, the 2nd preliminary tremor, the principal portion and the end portion; the principal portion being further divided, in most cases, into the three successive stages of the *initial phase*, the *slow-period phase* and the *quick-period phase.* Hence, setting aside the end portion, we may distinguish in distant earthquakes the following four essentially different epochs of motion :—

the 1st preliminary tremor;
the 2nd „ „

the *initial phase* (sometimes continuous with the slow-period phase) of the principal portion;
and the *quick-period phase* of the principal portion.

Let v_1 v_2 v_3 and v_5 denote the velocities of transit obtained by taking the moments of arrival of the beginning of the above four successive parts, and let us investigate what are the values of, and what may be the mutual relation between, these four velocities.

Denoting by y_1, y_2 and $y_{3,4}$ respectively the durations of the 1st preliminary tremor, the 2nd preliminary tremor, and of the joint initial and slow-period phases of the principal portion, we have, according to §§ 16 and 33,

$$y_2 = y_1 \times 0{,}95 \text{ ; and } y_{3,4} = y_1 \times 1{,}15 \text{ ;}$$

$$\text{or} \qquad y_1 = y_2 \times 1{,}05 = y_{3,4} \times 0{,}87 \ldots\ldots\ldots\ldots\ldots \text{(11)}$$

Thus we see that the three durations are nearly equal to one another, and we may write

$$y_1 \doteqdot y_2 \doteqdot y_{3,4} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(12)}$$

In the following discussion, however, I shall use equation (11).

If now t denotes the time interval between the occurrence of an earthquake and the arrival of the 1st preliminary tremor at a given station, and x the distance of the latter from the earthquake origin, we have the following relations :—

$$\left\{\begin{aligned} v_1 &= \frac{x}{t}, \\ v_2 &= \frac{x}{t + y_1}, \\ v_3 &= \frac{x}{t + y_1 + y_2}, \\ v_5 &= \frac{x}{t + y_1 + y_2 + y_{3,4}} \end{aligned}\right. \qquad \text{(13)}$$

From these we obtain, in virtue of equation (10), where the constant term is rejected :—

$$\left\{\begin{aligned}
\frac{1}{v_1}&=\frac{t}{x},\\
\frac{1}{v_2}&=\frac{t}{x}+\frac{y_1}{x}=\frac{1}{v_1}+\frac{1}{14,9},\\
\frac{1}{v_3}&=\frac{t}{x}+\frac{1}{x}(y_1+0,95\ y_1)=\frac{1}{v_1}+\frac{1,95}{14,9},\\
\frac{1}{v_5}&=\frac{t}{x}+\frac{1}{x}(y_1+0,95\ y_1+1,15\ y_1)=\frac{1}{v_1}+\frac{3,10}{14,9}
\end{aligned}\right. \qquad (14)$$

According to § 46 later on, the recent large Japanese earthquakes, observed in Italy and Germany, give 12,8 km. for the velocity v_1. Using this value, equations (14) give

$$\left\{\begin{aligned}
v_1&=12,8 \text{ km per sec.}\\
v_2&=\ 6,9\ \ ,, \quad ,, \quad =v_1\times\frac{1}{1,9}\\
v_3&=\ 4,8\ \ ,, \quad ,, \quad =v_1\times\frac{1}{2,7}\\
v_5&=\ 3,5\ \ ,, \quad ,, \quad =v_1\times\frac{1}{3,7}
\end{aligned}\right.$$

Thus roughly speaking v_2, v_3 and v_5 are respectively $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$ of v_1,

or $\quad v_1 \doteqdot 2v_2 \doteqdot 3v_3 \doteqdot 4v_5$..(15)

In the cases of the Japanese earthquakes observed in Italy and Germany, the mean values of v_2 and v_5 are respectively 7,1 and 3,3 km. per sec.

It is here to be remarked that the value of v_5 is very near to the velocity of transit of 3,3 km. per sec. found from an extended seismic triangulation in Tokyo, started in 1894 by the late Prof. S. Sekiya and myself, and since 1895, very ably continued by Mr. A. Imamura ; the velocity here quoted being the mean of observations of eight earthquakes.*

* The details of these experiments are given in Vols. XXI and XXXII of the (Japanese) Reports of the Earthquake Investigation Committee.

Equations (12) and (15) may possibly have certain physical meaning.

35. *The wave-length of the earthquake motion proceeding from distant origins.*—As stated in §§ 13—19, the principal vibrations in the 1st preliminary tremor have an average period of 8,03 s, while those in the initial phase of the principal portion have an average period of 31,3 s. The corresponding wave-lengths, λ_1 and λ_3, would, according to the results obtained in the preceding paragraph, be as follows :—

$$\lambda_1 = \overset{s}{8,03} \times \overset{km}{12,9} = 104 \text{ km},$$
$$\lambda_3 = 31,3 \times 4,8 = 150 \text{ ,,}$$

For the wave-length λ_5 of the quick-period phase of the principal portion, we have

$$\lambda_5 = \overset{s}{10,7} \times \overset{km}{3,5} = 38 \text{ km}.$$

The wave-lengths of the vibrations in the 2nd preliminary tremor may be similarly estimated.

The knowledge of the wave-lengths is important in considering the relation between the earthquake motion and the formation of the ground, as well as in the discussion of the nature of the slow-period earthquake undulations.

36. *On the paths of the earthquake waves through the earth's crust.* —As v_5 is very nearly equal to the velocity of propagation of the earthquake waves found by the seismic triangulation, it is probable that the waves in the quick-period phase of the principal portion are transmitted along the surface of the earth's crust. As regards other sets of the earthquake waves, those having the transit velocities of v_3 and v_4 may be propagated at some small depth within the earth's crust.

The transit velocity of the vibrations of the 1st preliminary tremor, namely v_1, is very great and no known rock has an elastic

modulus* sufficiently large to propagate with such a high velocity, whether the vibrations be longitudinal or transverse. Hence we must conclude that the waves of the 1st preliminary tremor are transmitted along some path within the earth's crust. As, however, the duration of the 1st preliminary tremor at a given station is very nearly proportional to the superficial distance between the latter and the earthquake origin, and, further, as this relation is the same for earthquakes both of distant and of near origin, it seems likely that the waves of the 1st preliminary tremor are transmitted nearly parallel to the surface of the earth and at a certain (probably constant) depth below it; the law of the 1st preliminary tremor, or generally the preliminary tremor, being explained on the supposition that the waves of the 1st and 2nd preliminary tremors and of the principal portion are all generated simultaneously at the earthquake origin, but are gradually separated from one another as the disturbance spreads from the latter on account of the difference of the transit velocities. The constant depth here assumed would be a small fraction of the radius of the earth.

---

* See Prof. H. Nagaoka's paper:—*The elastic constants of rocks and velocity of earthquake waves.* No. IV of the *Publications.*

APPENDIX.

THE VELOCITIES OF TRANSIT OF THE SEISMIC WAVES DEDUCED FROM THE OBSERVATIONS OF RECENT LARGE JAPANESE EARTHQUAKES IN ITALY AND GERMANY.*

37. *The earthquakes and the observing stations.*—I shall here calculate the velocities of transit of the waves of the following ten recent destructive or strong Japanese earthquakes, which were observed in Europe.

TABLE XVI.—LIST OF LARGE JAPANESE EARTHQUAKES OF RECENT YEARS.

No.	Date.	Time of occurrence in Tokyo.†	Position of the origin. Latitude, N.		Longitude, E.	
		h m s				
I	March 22nd, 1894	7. 27. 49 p.m.	42°	0′	146°	0′
II	June 15th, 1896	7. 34. 14 p.m.	39	0	143	20
III	„ 16th, „	4. 16, 30 a.m.	39	0	143	20
IV	„ „ „	8. 1. 14 a m.	39	0	143	20
V	Aug. 31st, „	5. 9. 33 p.m.	39	30	140	40
VI	Feb. 20th, 1897	5. 49. 23 a.m.	38	30	143	30
VII	Aug. 5th, „	9. 12. 23 a.m	38	30	143	30
VIII	„ 27th, „	1. 8. 46 a m.	39	0	143	0
IX	„ „ „	6. 19. 20 a.m.				
X	April 23rd, 1898	8. 37. 0 a.m.	39	0	142	45

Of the ten earthquakes, No. I was the great Hokkaido earthquake; No. II the earthquake which caused the great sea waves along the north-eastern coast of Japan; Nos. III and IV the after-

* This is the translation of a note by the present author written in May 1899 and published in Vol. XXIX of the Reports (Japanese) of the Earthquake Investigation Committee.

† The time is given, in the First Normal Japan Time, namely that of long. 135° E.

shocks of No. II; and No. V the great Riku-u earthquake. The remaining five earthquakes Nos. VI to X were each strongly felt in the eastern coast of the north of Honshiu (Main Island); Nos. VI and X, having caused some damage. Nos. VIII and IX had the same origin and are therefore treated conjointly.—All these earthquakes, with the exception of No. V, were of suboceanic origin and the position of their origins were determined from the study of the isoseismal lines.

The European observations, from which the velocities are calculated, have been taken from the *Bollettino della Società Sismologica Italiana*, except in the case of eqke No. VI which was observed by the present author at Potsdam, as already noted in § 33. The places of observation are given in the following Table.

LIST OF THE OBSERVATORIES.

Place.	Approximate position.			
	Latitude, N.		Longitude, E.	
Tokyo.	35°	41′	139°	45′
Padova.	45	24	11	54
Ischia.	40	46	13	59
Rocca di papa.	41	46	12	42
Rome.	41	54	12	29
Verona.	45	27	10	59
Pavia.	45	11	9	9
Catania.	37	29	15	4
Siena.	43	20	11	20
Potsdam.	52	23	13	4

38. *Method of calculation.*—The velocities were obtained by dividing the difference of the distances of Tokyo and the Italian (or German) stations from the earthquake origin by the corresponding difference of the times of arrival of the seismic waves. The calculation is made with respect to the commencements of the 1st and 2nd

preliminary tremors and of the quick-period phase of the principal portion ; these three different epochs correspond respectively to the 1st phase, the 2nd phase and the phase of the maximum motion in the reports of the Italian seismologists, and the times of thier commencement have been found, with the exception of eqke No. VI, from the detailed description given in the *Bollettino* already quoted. In accordance with the notation of § 34, let us call the three velocities respectively v_1 v_2 and v_3.

In the following, the time given is Greenwich mean time, counted from 0 to 24 hours. Following abbreviations are used :—

t_1=time of commencement of the 1st P. T.

t_2= „ „ „ „ „ 2nd P. T.

t_3= „ „ „ „ „ *quick-period phase* of the principal portion.

y_1=duration of the 1st P. T.

$y_{2,3}$= „ „ the 2nd P. T. and of the *initial phase* of the principal portion.

x=distance between the earthquake origin and an observing station.

39. *Eqke No. 1.*

Place.	t_1	t_2	t_3	x	y_1	$y_{2,3}$
	h m s	h m s	h m s		m s	m s
Padova.	10. 40. 55	——	——	9280 km.	——	——
Sisna.	10. 37. 11	10. 47. 47	11. 15. 11	9485	10. 36	27. 24
Roccadipapa.	10. 37. 00	10. 48.	11. 8.	9580	11. 0	20.
Rome.	10. 37. 20	10. 48.	10. 58.	9570	9. 40	11. 0
			mean.	8690 *	10. 25	19. 28
Tokyo.	10. 27. 49	——	——	885		

(* Padova excepted.)

The t_1 for Padova is somewhat different from those for the three other Italian stations and is consequently rejected in the calculation of the velocities. For v_1 we have

$$\text{Time difference: mean}\left\{\begin{matrix}\text{Siena.}\\ \text{Rocca di papa}\\ \text{Rome.}\end{matrix}\right. -\text{Tokyo}=9^{m}\ 21^{s};$$

$$\text{Distance difference: mean}\left\{\quad ,, \quad\right\}-\text{Tokyo}=8690\text{ km.}$$

$$v_1=\frac{8690^{km}}{9^{m}\ 21^{s}}=15{,}5\text{ km. per sec.}$$

Similarly comparing the means of t_2, t_3 and x for the same three Italian stations and the corresponding quantities for Tokyo, we obtain :—

$$v_2=\frac{8690^{km}}{19^{m}\ 50^{s}}=7{,}3\text{ km. per sec,}$$

$$v_3=\frac{8690^{km}}{39^{m}\ 15^{s}}=3{,}67\ ,,\quad ,,\quad ,,$$

40. *Eqke Nos. II, III and IV.*

No.	Place.	Time of occurrence.	t_3	x
II	Padova	$10^h\ 46^m\ 57^s$	$11^h\ 17^m\ 17^s$	9450 km.
	Rocca di papa	10. 56. 18	11. 20. 0	9720
	Rome	——	11. 19. 0	9720
	Ischia	10. 50. 29	11. 22. 0	9760
		mean	11. 29. 40	9663
	Tokyo	10. 34. 14	——	487
III	Padova	19. 28. 41	20. 3. 33	9450
	Rocca di papa	——	20. 3.	9720
	Rome	19. 56. 45	20. 4. 15	9720
	Ischia	19. 38. 47	——	9760
		mean	20. 3. 36	9663
	Tokyo	19. 16. 30	——	487
IV	Padova	23. 13. 27	23. 49. 46	9450
	Rocca di papa	——	23. 46.	9720
	Ischia	23. 23. 23	23. 49. 15	9760
		mean	23. 48. 20	9643
	Tokyo	23. 1. 14	——	487

The times of occurrence at the Italian stations do not well agree with each other and accordingly the y_1 and $y_{2,3}$ can not be determined. In each case, however, the time of occurrence at Padova was earlier than at other places and is therefore shall be assumed to correspond to t_1. For v_1 we have, by taking the distance and time differences :—

(Padova—Tokyo)

Eqke No. II : $v_1 = \dfrac{8960 \text{ km.}}{12^m \ 43^s} = 11{,}7$ km. per sec.

" " III : $v_1 = \dfrac{8960 \text{ km.}}{12^m \ 11^s} = 12{,}2$ " " "

" " IV : $v_1 = \dfrac{8960 \text{ km.}}{12^m \ 13^s} = 12{,}0$ " " "

mean $v_1 = 12{,}2$ " " "

With regard to t_5 the observations at the Italian stations well agre with each other. Hence we obtain :—

Eqke No. II :

$$\text{mean}\left\{\begin{array}{l}\text{Padova}\\ \text{Rocca di papa}\\ \text{Ischia}\end{array}\right\}\text{—Tokyo.}$$

$$v_5 = \frac{9176 \text{ km.}}{45^m \ 26^s} = 3{,}36 \text{ km. per sec.}$$

Eqke No. III :

$$\text{mean}\left\{\begin{array}{l}\text{Padova}\\ \text{Rocca di papa}\\ \text{Rome}\end{array}\right\}\text{—Tokyo.}$$

$$v_5 = \frac{9156 \text{ km.}}{47^m \ 6^s} = 3{,}41 \text{ km. per sec.}$$

Eqke No. IV :

$$\text{mean}\left\{\begin{array}{l}\text{Padova}\\ \text{Rocca di papa}\\ \text{Ischia}\end{array}\right\}\text{—Tokyo.}$$

$$v_5 = \frac{9156 \text{ km.}}{47^m \ 6^s} = 3{,}24 \text{ km. per sec.}$$

The mean of these three values gives

$$v_3 = 3{,}34 \text{ km. per sec.}$$

41. *Eqke No. V.*

Place.	t_1	t_2	t_3	x	y_1	$y_{2,3}$
	h m s	h m s	h m s	km	m s	m s
Rocca di papa	8 21. 30	8. 32. 30	9. 3. 40	9550	11. 30	31. 10
Rome	8. 21. 15	8. 31. 10	8. 58. 20	9550	9. 55	27. 10
Ischia	8. 20. 30	8. 32.	8. 57.	9580	11. 30	25. 0
Catania	8. 25. 24	8. 32 24	——	9810	7.	——
mean	8. 20. 55*	8. 32. 1	8. 59. 40	9625	10. 58*	27. 47
Tokyo	8. 9. 33	——	——	431	——	——

(* Catania excepted)

The t_1 at Catania, which is much different from those at other places, is rejected in the calculation of v_1. We have

$$v_1 = \frac{\overset{\text{km}}{9560} - \overset{\text{km}}{431}}{8^h 20^m 55^s - 8^h 9^m 33^s} = \frac{\overset{\text{km}}{9129}}{11^m\ 22^s} = 13{,}4 \text{ km. per sec.};$$

$$v_2 = \frac{9625 - 431}{8^h 32^m\ 1^s - 8^h 9^m 33^s} = \frac{9194}{22^m\ 38^s} = 6{,}77 \quad ,, \quad ,, \quad ,, \ ;$$

$$v_3 = \frac{9560 - 431}{8^h 59^m 40^s - 8^h 9^m 33^s} = \frac{9129}{50^m\ 7^s} = 3{,}05 \quad ,, \quad ,, \quad ,, \ .$$

42. *Eqke No. VI.*

Place.	Time of Occurrence.	t_2	t_3	x	y_1	$y_{2,3}$
	h m s			km		
Padova	20. 51. 23	——	——	9500	——	——
Verona	20. 58.	——	——	9540	——	——
		h m s				
Pavia	——	21. 42. 12	——	9640	——	——
Rocca di papa	——	21, 11.	——	9790	——	——
					m s	
Rome	20. 59. 50	21. 11. 45	——	9790	11. 55.	——
Ischia	21. 1. 25	21. 5. 11	——	9820	3. 46.	——
Catania	——	21. 5. 25	——	10040	——	——
			h m s			m s
Potsdam	21. 1. 5	21. 11. 0	21. 37. 5	8985	9. 55.	26. 5.
Tokyo	20. 49. 23	——	——	469	——	——

As, in this case, the observations in Italy do not well agree with each other, I shall calculate the velocities simply from the comparison of the observations at Potsdam and Tokyo.

$$v_1 = \frac{8516 \text{ km.}}{11^m\ 42^s} = 12{,}1 \text{ km. per sec.};$$

$$v_2 = \frac{8516}{21^m\ 37^s} = 6{,}6 \quad ,, \quad ,, \quad ,, \ ;$$

$$v_5 = \frac{8516}{47^m\ 42^s} = 3{,}0 \quad ,, \quad ,, \quad ,, \ .$$

43. *Eqke No. VII.*

Place.	t_1	t_2	t_5	x	y_1
Padova	0. 24. 0 (h m s)	——	——	9500 km.	——
Rocca di papa	0. 24. 52	0. 35. 20 (h m s)	0. 45. 10 (h m s)	9790	10. 28 (m s)
Rome	0. 23. 55	0. 34. 35	0. 58. 30	9790	——
Ischia	0. 24. 33	——	1. 2. 5	9820	——
Catania	0. 24. 53	0. 35. 4	1. 2. 30	10040	10. 11
mean	0. 24. 27	0. 35. 0	0. 57. 39	9788	10. 26
Tokyo	0. 12. 23	——	——	469	——

The velocities are calculated as follows :—

$$v_1 = \frac{9319 \text{ km.}}{12^m\ 4^s} = 12{,}9 \text{ km. per sec.};$$

$$v_2 = \frac{9404}{22^m\ 37^s} = 6{,}9 \quad ,, \quad ,, \quad ,, \ ;$$

$$v_5 = \frac{9391}{45^m\ 16^s} = 3{,}5 \quad ,, \quad ,, \quad ,, \ .$$

44. *Eqke Nos. VIII and IX.*

No.	Place.	Time of occurrence.	t_2	x	y_1
VIII	Rocca di papa	h m s 16. 46. 30	h m s 17. 56 35	9710 km.	m s 10. 5.
	Ischia	16. 24 19	——	9740	——
	Tokyo	16. 8 46	——	480	——
IX	Rocca di papa	22 3		9710	
	Rome	21 41 00			
	Ischia	21. 41 20			
	Tokyo	21. 19 29		480	

For eqke No. VIII, let us assume the times of occurrence at Ischia and Rocca di papa to represent respectively the t_2 and t_5. We have then :—

$$v_2=\frac{9260 \text{ km.}}{15^m\ 33^s}=9,9 \text{ km. per sec.};$$

$$v_5=\frac{9230}{47^m\ 49^s}=3,2 \quad ,, \quad ,, \quad ,, \ .$$

For equke No. IX, let us assume the time of occurrence at Rocca di papa to represent t_5, and those at Rome and Ischia t_2. We have then :—

$$v_2=\frac{9245 \text{ km.}}{22^m\ 15^s}=6,9 \text{ km. per sec.};$$

$$v_5=\frac{9230}{48^m\ 40^s}=3,2 \quad ,, \quad ,, \quad ,, \ .$$

Taking means of the results obtained from these two earthquakes, we obtain :—

$$v_2=8,4 \text{ km. per sec.}$$

$$v_5=3,2 \quad ,, \quad ,, \quad ,,$$

45. *Eqke No. X.*

Place.	t_1	t_2	x	y_1
Rome	$0^h.\ 48^m.\ 24^s$	$0^h.\ 53^m.\ 0^s$	9700 km	?
Rocca di papa	0. 49. 30	1. 0.	9700	$10^m.\ 30^s$
Ischia	0. 51. 0	0. 59. 20	9730	8. 20
Catania	0. 48. 58	——	9980	——
mean	0. 49. 28	——	9800	——
Tokyo	0. 37. 0	0. 37. 54	430	——

We have :-

$$v_1 = \frac{9370 \text{ km.}}{12^m\ 28^s} = 12{,}5 \text{ km. per sec.}$$

46. *Summary of results.*—The results obtained above are collected in the following table.

The transit velocities v_1 v_2 v_5, between Japan and Italy.

No. of Eqke.	v_1	v_2	v_5
I	km. per sec. 15,5	km. per sec. 7,3	km. per sec. 3,67
II	11,7	——	3,36
III	12,2	——	3,41
IV	12,0	——	3,24
V	13,4	6,77	3,05
VI	12,1	6,6	3,0
VII	12,9	6,9	3,5
VIII	——	8,4	3,2
IX	——		——
X	12,5	——	——
mean	12,8	7,2	3,3

Thus we obtain, for the transmission of seismic waves between Japan and Europe,

$$v_1 = 12{,}8 \text{ km. per sec.}$$
$$v_2 = \ 7{,}2 \quad ,, \quad ,, \quad ,,$$
$$v_3 = \ 3{,}3 \quad ,, \quad ,, \quad ,,$$

The mutual relation of the three velocities are as follows :—

$$v_2 = v_1 \times \frac{1}{1{,}8};$$

$$v_3 = v_1 \times \frac{1}{3{,}9}.$$

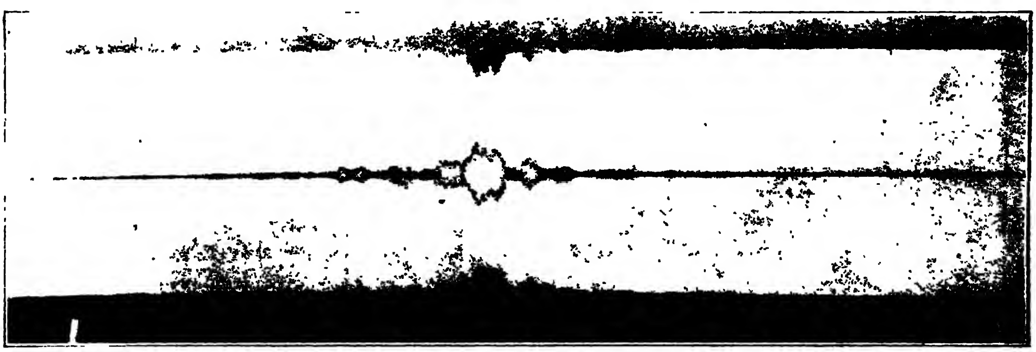
The duration of the 1st preliminary tremor, y_1, meaned from eqkes Nos. I, V and VII, observed in Italy is $10^m\ 3^s$, the corresponding mean distance between earthquake origin and the places of observation being 9580 km.

Plate XX.

Seismograms from Professor J. Milne's Horizontal Pendulum Apparatus.

(a). Earthquake of Sept. 1st 1898.
(Registered at Shide).

(b) Earthquake of Sept. 20th 1899.
(Registered in Tokyo).



1h 12h 11h

$\triangle T = +2m\ 22s$

Earthquake of Sept. 30th 1899.
(Registered in Tokyo).

3h 2h

$\triangle T = +11m\ 39s$

明治三十四年二月十三日印刷
明治三十四年二月十六日發行

震災豫防調査會

印刷者　齋藤章達
東京市日本橋區兜町二番地

印刷所　東京印刷株式會社
東京市日本橋區兜町二番地

PUBLICATIONS

OF THE

Earthquake Investigation Committee

IN

FOREIGN LANGUAGES.

NO. 6.

TŌKYŌ, 1901.

PUBLICATIONS

OF THE

Earthquake Investigation Committee

IN

FOREIGN LANGUAGES.

NO. 6.

TŌKYŌ, 1901.

HORIZONTAL PENDULUM OBSERVATIONS OF EARTHQUAKES, JULY 1898 TO DEC. 1899, TOKYO.

By

F. OMORI, D. Sc.,

Member of the Imperial Earthquake Investigation Committee.

CONTENTS

Introduction.

The present compilation, which is to be regarded as a supplement to Section II of the preceding volume, contains the analysis of the diagrams of 246 earthquakes observed in Tokyo, between July 1898 and Dec. 1899, by means of the horizontal pendulum seismographs with mechanical registration.

The 246 earthquakes, which are numbered in order of date, are divided according to their origin into the following nine groups.*

Group I. Distant Earthquakes.

Group II. Earthquakes which originated off the eastern coast of Hokkaido (Island of Yezo).

Group III. Earthquakes which originated off the north-eastern coast of Honshiu (Main Island).

Group IV. Earthquakes which originated off the coasts of the provinces of Hitachi and Iwaki.

Group V. Earthquakes which originated off the southern coast of Honshiu (Main Island).

Group VI. Earthquakes which originated in Kiushiu or off its eastern coast.

Group VII. Earthquakes which originated in central Japan.

Group VIII. Local earthquakes :—

(*a*). Those observed at several places.

---

* See Preface and Section II, No. 5 of the *Publications*.

(*b*). Those observed in Tokyo and at one other place.

(*c*). Those observed only in Tokyo.

Group IX. Earthquakes of miscellaneous origin.

All the seismograms described below were obtained, unless otherwise stated, from the horizontal pendulum seismographs *A* and *B* set up in the brick "earthquake-proof house" in the University compound, Hongo, Tokyo,* (long. 139° 44′ 30″ E, lat. 35° 39′ 15″ N) The specifications of these instruments are as follows.—

Horizontal Pendulum A : EW component.

Period** of free oscillation of pendulum = 28s.

Multiplication-ratio of pointer = 10.

Weight of heavy cylinder = 14 kg.

Length of horizontal strut, or distance between centre of heavy cylinder and point of support = 1 m.

Vertical distance between points of support and of suspension = 2,5 m.

Horizontal Pendulum B : NS component.—

Period of free oscillation of pendulum = 17 s.

Multiplication-ratio of pointer = 8,2.

In other respects, this apparatus is exactly similar to the apparatus *A*.

In the three cases of eqkes Nos. 234, 236 and 237, where the records from the apparatus *A* were not satisfactory, I have

---

* These instruments are described in Section III of the present Author's paper: "Horizontal pendulum, etc." Vol. XI, Jour. Coll. Sc. Imp. Univ. Tokyo.

** The term *period* is used always in the sense of *the complete period*.

substituted those from the newly constructed long-period horizontal pendulum apparatus *C*, also set up in the "earthquake-proof house," of the following specifications.*—

Horizontal Pendulum C: EW component.—

Period of free oscillation of pendulum = 120 s.

Multiplication-ratio of pointer = 10.

Weight of heavy cylinder = $7\frac{1}{2}$ kg.

Length of horizontal strut = 1 m.

Vertical distance between points of support and of suspension = 2,65 m.

I have analysed each of the diagrams of the 246 earthquakes on the assumption that the waves recorded are *horizontal movements* and not tiltings of the ground** ; that is, the range of motion or double amplitude was in each case deduced by dividing the actual trace on the seismogram by the multiplication-ratio of the pointer. Should the reader assume the movements to be due to tilting, he can at once obtain the magnitude of the recorded trace by multiplying the results given by the multiplication-ratio of the pointer.

In the description of the seismograms, the motion is generally divided into the three successive stages of *preliminary tremor*, *principal portion* and *end portion*. In many cases the preliminary tremor is further divided into two successive epochs of *1st preliminary tremor* and *2nd preliminary tremor*.*** The EW and NS component diagrams, though sometimes treated of conjointly, are generally taken separately and one of the component diagrams described more fully than the other, the preference being given

* Described in Section II, No. V of the *Publicatons.*

** See Section V, No. V of the *Publications.*

*** See Section II, ,,

to that which was better recorded. The durations of the *1st and 2nd preliminary tremors* and of the *principal portion* as well as the average periods of waves in the different epochs of the earthquake motion, given in Tables II to X, No. 5 of the *publications*, are the values obtained by taking the means from the EW and NS component diagrams.

I use the terms *waves*, *vibrations* and *undulations* all in the sense of *periodic movements*, with this distinction :—*vibrations* denote waves of quicker period, while *undulations* denote those of slower period.

Abbreviations used in the following descriptions of the seismograms are as follows.—

P.T. ....Preliminary tremor.
1st P.T.. ....1st preliminary tremor.
2nd P.T. ....2nd ,, ,,
P.P. ....Principal portion.
E.P. ....End portion.
2a.. ....Double amplitude, or range of motions
P.O. ....Pulsatory oscillations.

For most of the earthquakes of the Groups II to IX, the times of occurrence and the *intensities** as reported from several Meteorological Observatories are also given.—In the whole Empire there are at present 78 Meteorological Observatories, most of which are furnished with the ordinary seismographs of the Gray-Milne type. Their positions are given in the following Table.

* The *intensity* of ordinary non-destructive earthquakes is indicated as *strong*, *weak* or *slight*. A *slight* shock is one which is very feeble but just strong enough to be felt; a *weak* shock is one whose motion is well pronounced but not so severe as to cause general alarm ; and finally a *strong* shock is one which is sufficiently violent to knock down articles of furniture, to cause people to run out of doors, etc.

LIST OF METEOROLOGICAL OBSERVATORIES.

Locality.	Latitude N.		Longitude E.	
	°	′	°	′
Tokyo	35	41	139	45
Hiroshima	34	23	132	27
Matsuyama	33	50	132	45
Tadotsu	34	17	133	46
Kobe	34	41	135	11
Osaka	34	42	135	31
Kumamoto	32	48	130	42
Nagasaki	32	44	129	52
Fukuoka	33	35	130	23
Nagoya	35	10	136	55
Hakodate	41	46	140	44
Sapporo	43	4	141	21
Nemuro	43	20	145	35
Taihoku	25	4	121	28
Ishigakishima	24	20	124	7
Naha	26	13	127	41
Oshima	28	23	129	30
Kagoshima	31	35	130	33
Miyasaki	31	56	131	26
Kochi	33	33	133	32
Tokushima	34	6	134	37
Wakayama	34	14	135	9
Oita	33	14	131	36
Kure	34	14	132	33
Ajino	34	29	133	48

Locality.	Latitude N.		Longitude E.	
	°	′	°	′
Okayama	34	40	133	54
Shioya........................	34	46	134	23
Kyoto	35	1	135	46
Yagi	34	31	135	48
Saga	33	12	130	18
Saseho	33	10	129	42
Itangahara	34	12	129	16
Akamagaseki..............	33	58	130	56
Hamada	34	53	132	5
Sakai	35	33	133	14
Hikone	35	17	136	16
Gifu...........................	35	27	136	46
Tsu	34	43	136	31
Hamamatsu	34	43	137	43
Iida	35	31	137	51
Matsumoto	36	14	137	59
Kofu	35	40	138	34
Numazu	35	6	138	51
Nagatsuro	34	36	138	51
Yokosuka	35	17	139	40
Yokohama	35	27	139	39
Mera	34	55	139	50
Choshi........................	35	44	140	55
Mito...........................	36	23	140	28
Kumagae	36	9	139	23
Mayebashi..................	36	24	139	4
Utsunomiya	36	34	139	53

Locality.	Latitude N.		Longitude E.	
	°		°	
Fukui	36	3	136	16
Kanazawa	36	33	136	40
Wajima	37	23	136	53
Fushiki	36	47	137	3
Takayama	36	8	137	16
Nagano	36	40	138	10
Niigata	37	55	139	3
Yamagata	38	14	140	17
Akita	39	41	140	6
Fukushima	37	45	140	24
Ishinomaki	38	26	141	19
Miyako	39	38	141	59
Aomori	40	51	140	45
Suttsu	42	48	140	13
Soya	45	31	141	55
Erimo	41	55	143	15
Tokachi	42	55	143	12
Kamikawa	43	47	142	22
Kushiro	43	23	144	28
Abashiri	44	1	144	17
Koshun	22	4	120	47
Tainan	22	59	120	12
Hokoto	23	33	119	34
Taichu	24	2	120	40
Ashio	36	40	139	26
Kanayama	37	53	140	46

Horizontal Pendulum Observations of Earthquakes, July 1898 to Dec. 1899, Tokyo.*

GROUP I.—*Distant Earthquakes.*

Eqkc No. 2. July 15th, 1898; 1898; 2h 6m 14s a.m.
Total duration=1h 4m.

(NS component).

The 1st P.T., whose duration was 6m 40s, began very gradually and consisted essentially of regular vibrations of an average period of 4,9s, not superposed on slower undulations. The max. 2a was 0,02 mm. It may be added that there existed no P.O., so that the commencement of the earthquake was quite sharply defined.

The 2nd P.T., whose duration was 7m 35s, was characterized by the appearance of slower and larger undulations. During the first 3m the waves were regular and had an average period of 9,5s. For the next 1m, the amplitude was small and the average period was 3,1s. Later on waves of an average period of 8,1s predominated. A maximum motion of 0,1 mm occurred at 2m 6s from the commencement of the 2nd P.T., movements slightly larger than this also occurring towards the end of this epoch.

The P.P. began with well defined regular undulations which lasted for 2m 53s, and whose average period was 10,8s, the max. 2a of 0,55 mm occurring at 2h 2m 27s. Then followed an interval of rest, which comprised six small waves of an average period of 8,1s. The 2nd

---

* The time is given in the First Normal Japan Time, namely, that of longitude 135° E.

maximum epoch began at 2h 30m 14s and lasted for 2m; the average period being 11,6s, and a maximum 2a of 0,45 mm occurring at 11m 8s from the start. This was followed again by an interval of rest, which lasted for 36s, and consisted of small waves of an average period of 7,2s. The 3rd maximum epoch began at 2h 32m 55s and consisted of waves of an average period of 9,2s, the maximum 2a being 0,35 mm. So far may be regarded as the P.P., which thus lasted for 7m 54s.

The E.P. consisted of regular undulations, with occasional slight maxima. The average period, deduced from five successive groups of 50 vibrations, was as follows:—

8,6s	(at the commencement)	(General mean) 8,9s.
9,2		
8,8		
9,3		
8,5	(towards the end)	

In the P.P. and the E.P. the diagram shows a series of maximum movements, whose times of occurrence, counted from the commencement of the P.P., are as follows:—

m s	m s
0.34	21.32
1.57	22.18
5.03	23.56
6.25	25.16
7.47	26.23
9.37	27.29
12.02	29.29
13.22	31.25
14.41	32.01
16.32	32.48
17.20	33.55
19.29	35.05
20.13	36.03

m s	m s
37.11	44.14
38.45	45.55
40.30	47.21
41.39	

(EW component).

The 1st P.T., whose duration was 8m 2s, began gradually with small vibrations of an average period of 5,0s. The max. 2a was 0,02 mm.

The 2nd P.T., whose duration was 6m 53s, had an average period of 8,7s, there being also some slight traces of slower undulations. The max. 2a was 0,13 mm.

The P.P. The max. 2a of 0,35 mm. occurred at 2h 10m 48s. The average period deduced from six successive groups of 50 vibrations, was as follows :—

9,0s	(at the commencement)	(General mean) 9,0s.
7,9		
8,9		
9,4		
9,8		
9,0	(towards the end)	

In the P.P. and the E.P. the diagram showed a series of alternations of more or less distinct max. and min. epochs. The times of occurrence of the successive maximum movements, counted from the commencement of the P.P. were as follows :—

m s	m s
0.37	7.57
2. 7	9.20
3.46	11.18
4.43	12.35
5.53	13.57
7.27	15.57

m s	m s
17.14	23.20
18.27	24.11
19. 7	25. 0
19.54	25.39
20.27	26.42
21.40	27.48
22.24	etc., etc

Eqke No. 11. August 8th 1898; 4h 57m 35s p.m.

Total duration = 1h 20m.

This was a large earthquake at a great distance.

(NS component).

The P.T., whose duration was 7m 7s, began very gradually with vibrations of an average period of 4,2s, superposed on slower undulations of an average period of 9,3s.

The P.P. lasted 17m and consisted essentially of two series of waves whose average periods were respectively 16s and 10,2s. The max. 2a of 0,5 mm (period = 13,2s) occurred at 5h 17m 55s, and a second max. 2a of 0,35 mm (period = 13,6s) at 5h 23m 23s.

The E.P. The average period was 11,1s.

(EW component).

The P.T., whose duration was 6m 44s, consisted of small but well defined vibrations of an average period of 7,4s.

The P.P. began with 9 slow undulations which occupied 3m 12s and had an average period of 21,2s, the largest 2a being 0,25 mm. During the next 3m 5s the motion remained small and had a shorter average period of 13,5s. The followed the most active groups of vibrations, whose max. (abs.) 2a was 0,35 mm, and average period 10,8s.

The E.P. The average period was 9,8s.

Eqke No. 22. September 1st 1898; 5h 0m 57s a.m.

Total duration = 1h 45m.

This was a large earthquake at a great distance.

(NS component).

The 1st P.T. lasted for 8m 40s. During the first 1m 40s the motion was very small (max. 2a=0,05 mm), the average period being [illegible]. During the remaining 7m, the amplitude which was larger (max. 2a= 0,2 mm) remained nearly constant; the motion consisting of vibrations of an average period of 7,2s superposed on traces of others of average periods of 13,4s and 3,9s.

The 2nd P.T. lasted 4m 34s. The amplitude remained nearly constant (max. 2a=0,45 mm) and the principal average period was 13,9s. Towards the end there were some slow undulations of an average period of 24,3s.

The P.P., lasted 13m 20s. The motion was especially large during the first 7m 30s, which comprised three separate groups of vibrations, the second one having the greatest 2a of 8,1 mm. In each of these groups the motion gradually reached a maximum, probably on account of the synchronism of the pendulum with the shakings of the ground, the average period being 16,6s. In the remaining portion of this epoch, the average period was 12,8s.

The E.P. The average period deduced from four successive groups of 50 vibrations, taken at the commencement, was as follows :—

9,9s	(at the commencement)	(General mean) 11,2s.
11,5		
11,9		
11,5	(near the end)	

(EW component).

The 1st P.T. lasted 8m 45s. During the first 1m 37s the motion was very small, the average period being about 5s. During the remaining 7m 7s, the motion which was larger (max. 2a=0,25 mm) remained nearly constant or rather greater in the earlier than in the later part. The average period was 7,7s.

The 2nd P.T. lasted for 4m 47s. The max. 2a was 0,4 mm and the

principal average period 14,5s. Towards the end there were traces of slow undulations of an average period of 25s.

The P.P. lasted for 9m 45s, the motion being particularly active for the first 5m. It began with four slow undulations ,which lasted for 1m 49s and had an average period of 27,3s; the second wave having the max. 2a of 3,0 mm. The following five waves had a quicker average period of 16,8s and lasted for 1m 24s; the third one having the max. 2a of 3,2 mm. Then the vibrations became still quicker and had an average period of 11,3s; the second one having the max. 2a of 2,6 mm.

The E.P. The average period, measured at the commencement, was 10,4s.

Eqke No. 23. September 1st 1898; 6h 2m 17s p.m.

Total duration = 50m.

(NS component).

The P.T. lasted for 3m 14s, the motion being rather greater in the earlier and middle parts than in the end. The max. 2a was 0,35 mm and the principal average period 8,5s. There were also traces of small vibrations of an average period of 4,2s.

The P.P., whose duration was 12m 54s, began with two well pronounced waves of an average period of 15s, the first of which had a max. 2a of 1,2 mm. After 1m, there appeared quicker vibrations (max. 2a = 0,5 mm) which lasted for 1m 41s and had an average period of 4,8s. The subsequent motion consisted of quicker waves superposed on slower ones.

The E.P. The waves had an average period of 10,1s, being here and there superposed with smaller vibrations which were probably P.O.

(EW component).

The commencement was somewhat confused by the superposition of several lines. The P.T. lasted for about 3m 15s, its max. 2a being 0,24 mm.

The P.P. began with two well defined vibrations (max. 2a = 1,1 mm) whose average period was about 21s. These were followed by quicker ones, whose average period was 9,6s.

P.O. There existed slight P.O., whose average period was 5,3s.

The following observations at Naha and seven other Meteorological Observatories probably refer to the same earthquake:—

Naha	5h 57m 50s p.m.	Slight.
Oshima	6. 0. 5	Weak.
Ishigakijima	6. 3. 11	Strong.
Tokyo	6. 2. 19	Slight.
Kumagae	6. 2. 20	„
Mito	6. 2. 24	„
Taihoku	5. 58. 50	Weak.
Taichu	5. 46. 0	Slight.

Eqke No. 24. September 4th 1898; 0h 26m 49s a.m.

Total duration = 36m.

(NS component).

The P.T., whose duration was 7m 40s, consisted essentially of vibrations of an average period of 9,6s, superposed with small ones of an average period of 4,2s. These latter were probably P.O.

The P.P., whose duration was 7m 47s, consisted of undulations of an average period of 14.5s; the introductory movement having the max. 2a of 0,15 mm. The amplitude remained nearly constant during the first 4m 45s.

The E.P. consisted of quicker vibrations whose average period was 9,5s.

(EW component).

The P.P., whose duration was 7m 52s, consisted during the first 2m 12s of slow vibrations of an average period of about 13,2s. The succeding waves had essentially an average period of 9,5s. The max. 2a was 0,1 mm.

P.O. There existed slight quick P.O., whose average period, measured 1h before the earthquake, was 3,9s.

Eqke No. 29. September 14th 1898; 3h 2m 10s a.m.

Total duration = 1h.

principal average period 14,5s. Towards the end there were traces of slow undulations of an average period of 25s.

The P.P. lasted for 9m 45s, the motion being particularly active for the first 5m. It began with four slow undulations ,which lasted for 1m 49s and had an average period of 27,3s; the second wave having the max. 2a of 3,0 mm. The following five waves had a quicker average period of 16,8s and lasted for 1m 24s; the third one having the max. 2a of 3,2 mm. Then the vibrations became still quicker and had an average period of 11,3s; the second one having the max. 2a of 2,6 mm.

The E.P. The average period, measured at the commencement, was 10,4s.

Eqke No. 23. September 1st 1898; 6h 2m 17s p.m.

Total duration = 50m.

(NS component).

The P.T. lasted for 3m 14s, the motion being rather greater in the earlier and middle parts than in the end. The max. 2a was 0,35 mm and the principal average period 8,5s. There were also traces of small vibrations of an average period of 4,2s.

The P.P., whose duration was 12m 54s, began with two well pronounced waves of an average period of 15s, the first of which had a max. 2a of 1,2 mm. After 1m, there appeared quicker vibrations (max. 2a = 0,5 mm) which lasted for 1m 41s and had an average period of 4,8s. The subsequent motion consisted of quicker waves superposed on slower ones.

The E.P. The waves had an average period of 10,1s, being here and there superposed with smaller vibrations which were probably P.O.

(EW component).

The commencement was somewhat confused by the superposition of several lines. The P.T. lasted for about 3m 15s, its max. 2a being 0,24 mm.

The P.P. began with two well defined vibrations (max. 2a = 1,1 mm) whose average period was about 21s. These were followed by quicker ones, whose average period was 9,6s.

P.O. There existed slight P.O., whose average period was 5,3s.

The following observations at Naha and seven other Meteorological Observatories probably refer to the same earthquake :—

Naha	5h 57m 50s p.m.	Slight.
Oshima	6. 0. 5	Weak.
Ishigakijima	6. 3. 11	Strong.
Tokyo	6. 2. 19	Slight.
Kumagae	6. 2. 20	
Mito	6. 2. 24	"
Taihoku	5. 58. 50	Weak.
Taichu	5. 46. 0	Slight.

Eqke No. 24. September 4th 1898; 0h 26m 49s a.m.

Total duration = 36m.

(NS component).

The P.T., whose duration was 7m 40s, consisted essentially of vibrations of an average period of 9,6s, superposed with small ones of an average period of 4,2s. These latter were probably P.O.

The P.P., whose duration was 7m 47s, consisted of undulations of an average period of 14,5s; the introductory movement having the max. 2a of 0,15 mm. The amplitude remained nearly constant during the first 4m 45s.

The E.P. consisted of quicker vibrations whose average period was 9,5s.

(EW component).

The P.P., whose duration was 7m 52s, consisted during the first 2m 12s of slow vibrations of an average period of about 13,2s. The succeding waves had essentially an average period of 9,5s. The max. 2a was 0,1 mm.

P.O. There existed slight quick P.O., whose average period, measured 1h before the earthquake, was 3,9s.

Eqke No. 29. September 14th 1898; 3h 2m 10s a.m.

Total duration = 1h.

The beginning is perfectly well defined, the initial motion being 0,09 mm towards S.

The 1st P.T., whose duration was 8m 26s, consisted essentially of small well defined quick vibrations of an average period of 5,7s. Traces of waves of longer period did not exist. The motion was maximum at the commencement, becoming smaller towards the end.

The 2nd P.T., whose duration was 10m 26s, was characterized by a sudden increase in the amplitude and by the appearance of slower undulations, whose average period was 24,6s and whose max. 2a of 0,2 mm (first motion was directed towards S) occurred at the beginning; the motion becoming, as in the 1st P.T., smaller towards the end. These undulations were superposed with quicker vibrations which formed a continuation of those in the 1st P.T., (average period being 6,9s) and which ceased almost completely towards the end of this epoch.

The P.P. is characterized by the appearance of a series of regular slow undulations, free from superpositions, and lasted for 10m 34s, the motion being most active for an interval of 5m 37s from 1m 28s after the commencement. The first 5 waves were small and had an average period of 19s. Then followed seven large well defined undulations of an average period of 25s, the (absolute) max. 2a of 0,3 mm occurring at 3h 14m 27s a.m. These were followed by eight smaller (max. 2a=0,15 mm) and nearly equal vibrations of an average period of 22s. The motion then temporarily subsided, becoming again larger towards the end; these concluding vibrations having an average period of 19s.

In the E.P. again appeared traces of the small vibrations of an average period of 4,7s.; these being superposed on slower undulations, which were, however, probably the proper oscillations of the pendulum, as the average period was 17s.

The EW component diagram was somewhat obscured by the superposition of several lines. The max. 2a in this direction was 0,2 mm.

Eqke No. 33. September 22nd 1898; 9h 26m 11s p.m.
Total duration=3h.

This was evidently a large earthquake at a considerable distance. (EW component).

The 1st P.T., whose duration was 5m 37s, began very gradually with small movements of an average period of 3,4s. After about 2m 15s, the motion became more pronounced, consisting of waves of an average period of 9,2s, superposed with others of an average period of 5,4s. The max. 2a during this epoch was 0,12 mm and occurred towards the end of the latter.

The 2nd P.T., whose duration was 4m 18s, began with a displacement of 0,28 mm and consisted of undulations of an average period of 13,6s, superposed by small vibrations of an average period of 5,4s.

The P.P., whose duration was 18m 30s, was well defined and began with a displacement of 1,25 mm and of period 16,2s. The vibrations in the most active portion, which lasted for 6m 25s, had an average period of 14,3s; these being grouped more or less definitely into slower undulations of an average period of 28s, i.e. proper oscillations of the pendulum. The (abs.) max. 2a of 1,9 mm occurred at 3m 17s and also at 5m 8s from the commencement of the P.P., their period being 22s. In the part immediately following the most active epoch, the waves had an average period of 13,3s, interposed or superposed by smaller waves of an average period of 8,5s.

The E.P. consisted, for the first 6m 48s, of waves of an average period of 16,4s, superposed with smaller vibrations of an average period of 8,8s. After this, the slow period undulations disappeared, and the motion consisted entirely of vibrations of the same kind as above mentioned, the average period deduced from ten successive groups of 50 vibrations being as follows:—

9,1s
9,2
9,9
9,6
9,0 (General mean
9,6 9,6s.
9,2
9,6
10,0
10,3

(NS component).

The max. 2a of 1,9 mm occurred at 5m 8s from the commencement of the P.P.

Eqke No. 35. September 25th 1898; 9h 22m 46s p.m.

Total duration = about 30m.

This was an earthquake at a great distance and began very gradually. The time interval between the commencement of the earthquake (which was not quite sharply defined) and the beginning of the P.P. was 10m 50s.

The earlier part of the P.P. consisted of slow waves of an average period of 20s, superposed with small vibrations of an average period of 8,2s. The max. 2a was 0,05 mm in the EW and 0,04 mm in the NS component.

In the E.P., the average period was 10,4s.

Eqke No. 40. October 1st 1898; 1h 29m 12s a.m.

Total duration = about 4m.

This was a small earthquake at some distance, the motion being very small.

Eqke No. 43. October 10th 1898; 7h 35m 39s a.m.

Total duration = 48m.

The P.T. was not definitely recorded, having been probably lost on account of the smallness of motion.

This was a small earthquake at a great distance.

The average period in the P.P. was 22s.

Towards the end, the average period was 14s.

Eqke No. 44. October 12th 1898; 1h 45m 38s a.m.
Total duration = $2\frac{1}{2}$h.

This was evidently a large earthquake at a great distance. Traces of slow undulations continued to be seen more or less definitely for $4\frac{1}{4}$ hours after the time interval given above as the total duration of the shock. As there was no P.O. before the earthquake this shows that the ground remained for several hours in a disturbed state. The 1st and 2nd P.T. and the P.P. were all well defined, the very initial motion being 0,1 mm towards N and 0,08 mm towards E. (NS component).

The 1st P.T., whose duration was 6m 3s, consisted essentially of waves of an average period of 9,1s, superposed with smaller vibrations of an average period of 4,5s (2a = 0,1 mm). The max. 2a of 0,2 mm occurred at the commencement, the motion lessening towards the end of this epoch. Traces of vibrations of longer period did not exist.

The 2nd P.T. whose duration was about $2\frac{1}{2}$m, was marked by an abrupt increase in the amplitude and consisted essentially of vibrations of an average period of 7s, superposed on slow undulations of an average period of about 15s; the max. 2a of 0,25 mm being the first motion of this epoch, directed towards S.

The P.P., whose duration was 6m 26s, began at 1h 53m 57s a.m. with ill defined traces of slow undulations of an average period of 37,5s, superposed with other irregular vibrations of an average period of 21s. Besides these, small vibrations of an average period of 7,5s continued to exist till 1h 58m 1s a.m., i.e. 12m 32s after the commencement of the earthquake, when the (abs.) max. 2a of 0,75 mm took place followed by seven large well defined waves of nearly an equal amplitude. These 8 waves, toge-

then occupying a time interval of 2m 52s, formed the most conspicuous part of the motion and had an average period of 21,5s. The succeding movements, whose average period was 19,7s, were again superposed with small vibrations of an average period of 7,4s.

The E.P. consisted essentially of waves, whose average period deduced from ten successive groups of 50 vibrations was as follows:—

8,4s	(at the commencement)	(General mean 9,3s.)
8,4		
8,7		
10,4		
9,0		
9,5		
9,7		
8,6		
10,0		
9,8	(near the end)	

During the first 16m of this epoch, there were also some slight traces of undulations of an average period of 18s. Near the end, slight maxima occurred at nearly regular intervals.

(EW component).

The 1st P.T., whose duration was 5m 57s, consisted of vibrations of an average period of 7,6s, superposed here and there with traces of very small vibrations of an average period of 1,7s; long-period undulations did not exist. The max. 2a was 0,2 mm.

The 2nd P.T., whose duration was 3m 43s, began with an abrupt motion of 0,5 mm towards E, and consisted of 12 slow undulations of an average period of 18,6s; these being again superposed with small waves of an average period of 7,4s. Slight traces of slow waves of an average period of 37s seemed also to exist. The amplitude decreased towards the end of the epoch.

The P.P., whose duration was about 15m, began with 10 well defined slow undulations of an average period of 25s, whose max. 2a of 0,8 mm

occurred at 1h 56m 43s; these waves being superposed with small undulations of an average period of 7,2s. The latter then almost disappeared and there appeared 9 well defined, waves of an average period of 21s; of these the first was the maximum, having a range of 0,45 mm. In the remaining portion of this epoch the motion was much smaller.

The E.P. The average period, measured at about ½h from the beginning of the earthquake, was 8,6s.

Eqke No. 45. October 19th 1898; 4h 27m 48s a.m.

Total duration = 39m.

This was a small earthquake at some distance, the motion consisting of regular vibrations free from superpositions, chiefly in the NS component.

The P.T. lasted for about 8m 26s.

The P.P. In the earlier portion of this epoch, the average period was 11s; later on it was 19s. The max. 2a was 0,7 mm in the NS and very small in the EW component.

Eqke No. 47. October 22nd 1898; 9h 2m 42s a.m.

Total duration = 1h 7m.

(EW component).

The P.T. lasted 9m 12s and consisted of small but well defined vibrations of an average period of 7,6s, the amplitude remaining nearly constant.

The P.P., whose duration was 9m, began with small slow undulations (max. 2a = 0,15 mm) which lasted 4m 39s and had an average period of 31s, superposed with small quicker vibrations of an average period of 8,9s. Then followed the most active group of waves, whose average period was 20s, and whose first displacement had the max. 2a of 0,3 mm.

The E.P. The average period was as follows:—

10,9s (at the commencement);

16,5 (towards the end).

(NS component).

The P.T., whose duration was 10m 32s, consisted of vibrations of an average period of 8,1s; the amplitude remaining nearly constant.

The P.P. lasted about 7m. For the first 4m 26s the motion was slow (max. 2a=0,14 mm), the average period being 27s. Then followed quicker vibrations of an average period of 17,5s, the first of the group having the max. 2a of 0,15 mm.

Eqke No. 48. October 22nd 1898; 10h 35m 53s p.m.

Total duration=20m.

The commencement was not well defined, but the P.T. lasted for about 1m 43s and consisted of waves of an average period of 2,7s, superposed more or less distinctly on slow undulations of an average period of 12s.

The P.P. lasted for 4m 30s. During the first 1m 26s, the average period was 7,8s, the max. 2a being 0,08 mm in the EW and 0,05 mm in the NS component. Later on the waves had an average period of 7,4s, superposed with small vibrations of an average period of 3,8s.

The E.P. The average period was 5,6s, the waves being regular.

Eqke No. 50. November 2nd 1898; 8h 43m 15s p.m.

Total duration=about 17m.

The motion was very slight and began gradually.

The P.T. lasted for about 6m (?) and had an average period of 6,7s.

The P.P. The average period was 7,6s, and the max. 2a was 0,04 mm in each component.

Eqke No. 51. November 5th 1898; 8h 48m 45s p.m.

Total duration=about 15m.

This was a small earthquake at a great distance, the motion being very small.

The P.T. was not well defined.

In the P.P., the average period was 18s.

Eqke No. 57. November 14th 1898; 4h 5m 23s p.m.

Total duration = 40m.

This was a small earthquake at some distance.

The P.T., whose duration was 1m 28s, consisted of very small vibrations of an average period of 5,9s, superposed with traces of quicker ones of an average period of about 2,3s.

The P.P., whose duration was 7m, consisted, during the first 3m 29s, of very small vibrations superposed on waves of an average period of 5,2s. Then took place the max. 2a of 0,24 mm in the EW and 0,19 mm in the NS component, followed by well defined vibrations whose average period, deduced from four successive groups of 50 vibrations, was as follows:—

$$\left.\begin{array}{l}7{,}1\text{s}\\7{,}8\\8{,}7\\8{,}6\end{array}\right\}\begin{array}{c}\text{(General mean)}\\8{,}1\text{s.}\end{array}$$

P.O. There existed slight traces of P.O., whose average period was 5,6s.

Eqke No. 58. November 17th 1898; 9h 54m 53s p.m.

Total duration = 2h 30m.

This was a large earthquake at a distance.

(EW component).

The P.T., whose duration was 4m 8s, consisted of vibrations of an average period of 8,4s, superposed with some traces of smaller ones of an average period of 5,6s. The max. 2a was 0,12 mm.

The P.P., whose duration was 11m 30s, began with 6 slow undulations which lasted 2m 32s and had an average period of 25,4s, the first vibration having the largest 2a of 1,0 mm. So far may probably be taken as the 2nd P.T., and the motion was superposed with small vibrations of an average period of 6,9s. Then followed the most active part of the motion, which lasted 4m 40s and comprised three nearly equal maximum groups of vibrations with two minimum groups between them; the max. 2a

[illegible] 1,5 mm. During the first 2m 10s of this latter epoch the average period was 21,7s, and during the remaining 2m 30s it was 15,2s. The following vibrations had an average period of 13,4s.

The E.P. There were alternations of slight maximum and minimum groups of vibrations. The average period deduced from seven successive groups of 50 vibrations, taken at the commencement of this epoch, was as follows:—

13,0s
13,0
12,0

(After these the period became constant and somewhat quicker).

10,0s	(General mean) 10,5s.
11,0	
11,0	
10,0	

Towards the very end the average period was 11,0s.

(NS component).

Here the 1st and 2nd P.T. may be distinguished.

The 1st P.T., whose duration was 4m 21s, consisted essentially of small vibrations of an average period of 8,4s, superposed with traces of smaller and quicker ones. The max. 2a was 0,12 mm.

The 2nd P.T., whose duration was about 2m, began with the max. 2a of 0,55 mm. The motion consisted of small vibrations of an average period of 7,2s, superposed more or less distinctly on traces of slow undulations of an average period of about 25s.

The P.P., whose duration was 9m 40s, consisted, during the first 4m 28s, of slow undulations grouped into three nearly equal maximum groups, (max. 2a=1,7 mm); the average period being 21,6s. Then followed the most active group of vibrations (max. 2a=3,1 mm), which, however, were probably in a part due to the proper pendulum oscillations, the average period being 16,7s.

The E.P. The average period, deduced from six successive groups of 50 vibrations, taken at about 45m after the commencement of the earthquake, was as follows:—

$$\left.\begin{array}{r} 10{,}2\text{s} \\ 10{,}2 \\ 9{,}4 \\ 10{,}9 \\ 11{,}4 \\ 10{,}8 \end{array}\right\} \begin{array}{c} \text{(General mean)} \\ 10{,}5\text{s.} \end{array}$$

Eqke No. 61. November 22nd 1898; 8h 20m 3s p.m.

Total duration = 1h 13m.

(NS component).

The beginning of the motion was not well defined. The time interval between the assumed commencement and the appearance of the P.P. was about 6m 30s.

The P.P. The max. 2a was 0,06 *mm* and the average period in the earlier portion was 12s.

The E.P. The average period was 9,8s.

The EW component diagram was lost on account of the stoppage of the clock-work of the corresponding machine.

Eqke No. 64. November 30th 1898; 7h 31m 18s a.m.

Total duration = 17m.

The beginning of the motion was very gradual but well defined.

The P.T. was not well defined, but the time interval between the beginning and the epoch of the maximum activity of motion was 5m 30s. During this portion, the motion consisted of very small ill defined waves of an average period of about 7,1s, superposed with traces of others still smaller.

The P.P. lasted for about 1½m. The max. 2a was 0,04 mm in each component, and the average period was 7,6s.

Eqke No. 65. Dec. 1st 1898; 9h 53m 53s p.m.

Total duration = 33m.

The beginning was not sharply defined, and the motion increased gradually, reaching the maximum epoch about 6m 20s later on.

The P.P. The average period was 15s, and the max. 2a was 0,06 mm in the EW and 0,02 mm in the NS component, the motion being very small in the latter component.

The E.P. The average period was 12s.

P.O. There were very slight P.O., whose average period was 4,1s.

Eqk No. 69. December 11th 1898; 3h 39m 22s p.m.

Total duration = 1h 18m.

This was a large earthquake at a great distance. The commencement of motion was gradual but well defined.

(EW component).

The 1st P.T., whose duration was 9m 58s, consisted of very small and indistinct vibrations of an average period of 6s.

The 2nd P.T., whose duration was 6m 7s, was characterized by the appearance of more pronounced vibrations, whose average period was 7,6s. The max. 2a was 0,02 mm, the amplitude remaining nearly constant or being rather slightly greater at the commencement than at the end.

The P.P. began at 3h 55m 18s with traces of small slow undulations, whose average period was 27,5s, superposed with small vibrations of an average period of 8,0s. From 4h 0m 48s set in regular well defined undulations (max. 2a = 0,05 mm), with slight alternations of maxima and minima epochs. Their average period, deduced from four successive groups of 20 waves were as follows:—

$$\left.\begin{array}{l} 17{,}9\text{s} \\ 17{,}9 \\ 17{,}0 \\ 16{,}8 \end{array}\right\} \begin{array}{c} \text{(General mean)} \\ 17{,}4\text{s.} \end{array}$$

At about 1h 1m from the commencement of the earthquake there appeared again a slight maximum group, the motion having been almost perfectly nil for the preceding 14m.

(NS component).

The 1st P.T., whose duration was 9m 50s, consisted of very small vibrations of an average period of about 7,3s, these being superposed with traces of vibrations of still quicker period.

The 2nd P.T., whose duration was 12m 12s, consisted of vibrations of an average period of 7,7s. The max. 2a was 0,05 mm, the motion being more pronounced at the commencement than at the end.

The P.P. began with 17 well defined slow undulations, which formed the maximum group (max. 2a=0,06 mm), and whose average period was 23s, occupying together 6m 31s. For the next 5m 20s the motion was small, and the average period was 18,8s. Then followed a second maximum group of 16 undulations (max. 2a=0,05 mm) which together occupied 4m 36s, the average period being 17,2s. After this the motion decreased.

Eqke No. 76. December 30th 1898; 11h 23m 49s p.m.
Total duration = about 13m.

The P.T., whose duration was 32s consisted of very quick small movements.

The P.P., whose duration was 6m 30s, began with a motion of 0,08 mm towards E and also 0,08 mm towards N. For the first 1m, the motion consisted of sharp quick vibrations (max. 2a=0,4 mm in the EW and 0,3 in the NS component) superposed on others whose average period was 2,6s, and whose max. (abs.) 2a of 0,4 mm in the EW and 0,35 mm in the NS component occurred at 1m 2s from the beginning of this epoch. There were also slower waves whose average period was 7,6s and whose max. 2a was 0,34 mm in the EW and 0,3 mm in the NS component. From about 11h 26m 47s there appeared well defined vibrations of an average period of 3,3s, their max. 2a being 0,35 mm in the EW and 0,26 mm in the NS component.

The E.P. Near the end the average period was about 5,8s.

P.O. There was a storm of small and quick P.O., the max. 2a being 0,04 mm in each component. Their average period was as follows:—

4,4s (measured just before the earthquake).
4,3 („ „ after „ „)

Eqke No. 82. January 23rd 1899; 11h 9m 57s p.m.
Total duration = 27m.

(NS component).

The P.T. whose duration was 6m 45s, consisted of vibrations of an average period of 8,3s, superposed with others still smaller.

The P.P. lasted for 5m 47s, the motion being however comparatively small during the first 1m 38s. The waves, whose max. 2a was 0,13 mm, had an average period of 8,3s, superposed with smaller vibrations of an average period of 3,7s.

The E.P. was more or less active during the first 4m 15s, the average period being 8,0s.

(EW component).

The P.T. lasted for 6m 38s, and the max. 2a was 0,08 mm.

Eqke No. 84. January 27th 1899; 10h 47m 32s p.m.
Total duration = about 7m 20s.

This was a small earthquake at a distance, the motion consisting of regular vibrations.

(EW component).

The P.T., whose duration was 54,5s, consisted of regular small vibrations of an average period of 1,95s, superposed on traces of slower waves of an average period of 6,4s.

The P.P., whose duration was 2m 26s, consisted of well defined vibrations of an average period of 4,7s. The max. 2a was 0,05 mm.

(NS component).

The max. 2a was 0,04 mm.

P.O. There were some slight traces of quick P.O. Their average period, measured about 5h after the earthquake, was 4,1s.

Eqke No 86. February 1st 1899; 2h 52m 43s p.m.
Total duration = 26m.

This was a small earthquake at some distance. The beginning of the motion was somewhat obscured by the existence of slight P.O.

The P.T. lasted for 5m 35s and showed some doubtful traces of slow undulations of an average period of 20s, superposed with the same small vibrations as occurred in the P.P.

The P.P. consisted of vibrations of an average period of 9,2s, the max. 2a being 0,05 mm in each component.

Eqke No. 88. February 11th 1899; 4h 52m 3s p.m.

Total duration = about 27m.

This was a small earthquake at some great distance. The beginning and end of the diagram was confused by the existence of strong P.O.

(NS component).

The duration of the P.T. was doubtful.

The P.P. began from about 1m 13s from the assumed beginning of the earthquake. For the next 22m the amplitude remained very nearly constant, with occasional alternations of max. and min. groups. The max. 2a was 0,07 mm in the EW and 0,08 mm in the NS component.

(EW component).

The motion was small for the first 6m 58s, which probably may be taken as the P.T.; the average period was 5,3s. After this, there appeared traces of slow undulations whose average period was 22s.

P.O. Immediately before the commencement of the earthquake, the average period of the P.O. was 7,8s, the max. 2a being 0,04 mm. Again a little after the earthquake, the average period was 3,9s, the max. 2a being 0,03 mm. A change in the period of P.O., like this, is rather rare.

Eqke No. 93. February 28th, 1899; 11h 48m 55s a.m.

Total duration = 1h 30m.

This was a moderately large earthquake at a great distance. The beginning of the diagram was obscured by the presence of slight P.O.

(EW component).

The P.T., whose duration was 7m consisted of vibrations of an average period of 7,3s.

The P.P., whose duration was 23m, had no single prominent maximum motion but consisted of a number of alternations of max. and min. groups. The max. 2a was 0.16 mm in the EW and 0,22 mm in the NS component.

(NS component).

The average period in the P.P., deduced from 3 successive groups of 50 vibrations, were as follows :—

$$\left.\begin{array}{l} 9{,}8\text{s} \\ 9{,}2 \\ 8{,}9 \end{array}\right\} \begin{array}{c}\text{(General mean)} \\ 9{,}1\text{s.}\end{array}$$

Eqke No. 95. March 3rd 1899; 9h 50m 2s a.m.

Total duration = about 20m.

This was a small earthquake at a distance. The beginning and end of the diagram was confused by P.O.

(NS component).

The motion began very gradually. The P.P. whose duration was about 5m 15s set in at about 5m 30s from the assumed commencement of the earthquake, the average period being 15,8s. The max. 2a was 0,22 mm.

(EW component).

The max. 2a = 0,05 mm.

The P.O. had an average period of 4,5s, its max. 2a being 0,03 mm in each component.

Eqke No. 97. March 6th 1899; 11h 36m 8s p.m.

Total duration = about 25m.

This was a small earthquake at some distance.

(NS component).

The exact beginning as well as the end of the motion was somewhat obscure on account of the presence of P.O.

The P.T. lasted for about 5m 28s.

The P.P. consisted of a group of vibrations of an average period of 7,9s, followed by alternations of very slight max. and min. epochs.

P.O. The average period, measured about 1h after the commencement of the earthquake, was 7,7s.

(The EW component diagram was obscured by the superposition of lines.)

Eqke No. 98. March 7th 1899; 4h 39m 50s a.m.

Total duration = about 1h.

This was a moderately large earthquake at some distance.

The commencement of the motion was obscured by P.O., but the time interval between the assumed beginning and the occurrence of the max. 2a (= 0,06 mm in each component) was 22m 20s. The P.P., whose duration was about 18m, consisted of vibrations of an average period of 8,7s.

The E.P. The average period, measured about 1½h after the commencement of the earthquake, was 8,0s.

Eqke No. 102. March 15th; 6h 9m 14s a.m.

Total duration = 21m.

This was a small earthquake at some distance.

The commencement of the motion was obscured by the presence of small and quick-period P.O.

(EW component).

The P.T. was not well defined. During the first 2m 25s the average period was 12,1s. Then the motion became slightly quicker, the average period in the next 4m being 7,7s. The group of the most active movements occurred at about 7¼m from the commencement of the earthquake, the max. 2a being 0,05 mm. What may be regarded as the P.P. lasted for about 7m 20s.

(NS component).

The max. 2a was 0,15 mm.

P.O. The average period, measured 1h after the earthquake, was 3,8s.

Eqke No. 107. March 21st 1899; 11h 35m 44s p.m.

Total duration = 44m.

This was evidently a moderate earthquake at some great distance.

(EW component)

The P.T. was not definitely shown, but its duration may be taken at about 4m 13s. For the first 26s, the motion was small; then a displacement of 0,2 mm took place, and thereafter the amplitude remained nearly constant for 3m 47s, the average period being 7,8s.

The P.P., whose duration was 9m 46s, consisted of vibrations of an average period of 8,3s, superposed at first on slow undulations of an average period of 25,4s. The max. 2a of 0,36 mm occurred at 11h 41m 48s.

The E.P. The average period, deduced from three successive groups of 50 vibrations, was as follows:—

8,0s	General mean 8,2s.
8,2	
8,5	

(NS component).

For the first 34s the motion was small, then took place a motion of [illegible] mm, the amplitude remaining nearly constant for the next 4m 2s. After this the motion became larger.

Eqke No. 110. March 23rd 1899; 8h 30m 59s p.m.

Total duration = about 23m.

The P.T. The commencement was somewhat obscure but the time interval between the assumed beginning and the occurrence of the maximum group was 6m 8s.

The P.P. consisted of traces of very slow undulations of an average period of 23,5s.

Eqke No. 111. March 23rd 1899; 9h 23m 14s p.m.

Total duration = 28m.

This was a small earthquake at some distance and the motion began very gradually.

The P.T. was not well defined, but its duration may be taken to be about 10m 30s. The average period was 4,3s.

The P.P. had an average period of 7,4s, the maximum motion (0,03 mm in the NS and 0,05 mm in the EW) occurring near its commencement. From about 9h 30m 35s there appeared some traces of slow undulations of an average period of 20s.

Eqke No. 113. March 24th 1899; 0h 29m 5s a.m.

The diagram merely shows a trace of a distant small earthquake.

Eqke No. 126. April 16th 1899; 11h 1m 34s p.m.

Total duration = about 1h 5m

This was a small earthquake at a great distance. The commencement was somewhat obscure, the motion being too small.

(NS component).

The P.T. lasted for 17m 10s and consisted of traces of vibrations of an average period of 8,4s.

The P.P., whose duration was 26m, began gradually with traces of slow undulations. After 4m 20s there appeared regular well defined vibrations, whose average period was 8,7s, and whose max. 2a was 0,1 mm in the EW and 0,05 mm in the NS component. This max. 2a was not prominent, but there were a great number of alternations of nearly similar max. and min. groups; the maxima occurring at an average interval of 1,2m.

The motion ceased almost completely at 0h 15½m p.m.; but a new slight trace of disturbance again occurred at 0h 48½m p.m., with an average period of 8,5s.

(EW component).

The P.T. lasted for 17m 59s.

The P.P. The average period of the vibrations was 9,2s. The groups of maximum amplitude occurred at an average interval of 1,6m, the greatest group occurring at 9¼m from the commencement.

Seismogram No. 127. April 17th 1899; 10h 46m 50s a.m.

Total duration = 1h 57m.

This was a large earthquake at a great distance.

As there was no P.O. before the earthquake, the commencement of the latter was perfectly clear. The 1st and 2nd P.T. as well as the P.P. were also well defined.

(EW component).

The 1st P.T., whose duration was 9m 0s, began very gradually. After 1¼m, however, the motion increased, the max. 2a being 0,04 mm. The average period was 7,2s.

The 2nd P.T., whose duration was 10m 8s, was characterized by an increase in the amplitude, which remained sensibly constant throughout this epoch or rather slightly decreasing towards the end. The max. 2a was 0,07 mm, and the average period was 7,8s. There were also some traces of slow undulations.

The P.P., whose duration was 29m 26s, began with a group of well defined (abs. max.) slow undulations of nearly an equal amplitude, which together occupied 7m 43s and had an average period of 20s. Of these, the first 8 vibrations were particularly slow and had an average period of 26s, the max. 2a being 0,14 mm. Superposed on these slow undulations there were smaller waves of an average period of 11,9s. The motion for the next 5m 5s consisted of well defined quick regular undulations, whcse max. 2a was 0,05 mm and whose average period was 9,2s. The motion during the remaining 16m 38s was as follows:—

For 2m 48s, the motion was composed of well pronounced quick vibrations, superposed on traces of slow undulations.

For the next 2m 31s, there were 9 well defined slow regular undulations, (max. 2a = 0,1 mm) of an average period of 16,8s, forming the second max. group.

For the next 2m 25s, the motion was small and quick-perioded.

For the next 2m 14s, there were 8 slow and regular waves (max. 2a = 0,08 mm) of an average period of 16,8s, forming the third max. group.

For the next 2m 5s, the motion was again small and quick-periodedl.

For next 4m 35s, there were 17 well defined slow undulations (max. 2a=0,08 mm) and of an average period of 16,2s, forming the fourth max. group.

The E.P. consisted of small regular vibrations whose max. 2a was less than 0,05 mm, and which showed occasional alternations of max. and min. groups. The average period was:—

9,2s (measured at the commencement),
8,7 (,, towards the very end).

(NS component).

The 1st P.T. lasted for 9m 33s, and consisted of vibrations, whose max. 2a was 0,03 mm and whose average period was 6,3s.

The 2nd P.T. lasted for 9m 7s and consisted of vibrations whose max. 2a was 0,07 mm and whose average period was 8,1s. There were alternations of max. and min. groups. Thus, beginning with the commencement of the 2nd P.T., that is 10h 56m 14s:—

for the first 40s, the motion was small;
then occurred a single max. vibration;
then the amplitude became very small;
at 10h 57m 47s commenced a max. group, lasting 58s;
at 10h 59m 44s commenced another max. group, lasting 34s;
at 11h 0m 26s commenced a third max. group, lasting 39s, etc.

The P.P. began gradually. For the first 1m 30s the motion was small, the average period being 15s. Then followed 8 large slow undulations which together occupied 3m 12s, and had an average period of 31,5s, their max. (abs.) 2a being 0,14 mm. These were followed by small vibrations which lasted 2m 56s. During the next 1m 28s the motion was slightly increased. Thereafter it became small and the predominating vibrations had an average period of 14s, superposed with vibrations of shorter period.

The E.P. The average period, measured towards the end, was 8,9s.

P.O. The max. 2a was 0,04 mm in each component, the average period being as follows:—

5,1s (measured at about 7¼ a.m., April 18th),
4,9s („ „ 6½ „ „

Eqke No. 130. April 23rd 1899; 0h 15m 2s a.m.
Total duration = 3m.

This was a small earthquake at some distance. The commencement was somewhat obscured by P.O. The P.P., however, occurred about 2m after the assumed beginning.

The P.P. lasted 1m 29s. The average period was 7,4s, and the max 2a was 0,05 mm in the EW and 0,03 mm in the NS component.

The E.P. was obscured by P.O.

P.O. The max. 2a was 0,05 mm in each component and the average period, measured 1h before the earthquake, was 4,0s.

Eqke No. 133. May 2nd 1899; 11h 36m 47s p.m.
Total duration = 1h.

This was a small earthquake at a great distance, and the motion began very gradually.

(EW component).

The P.T., whose duration was 5m 19s, was well defined and showed traces of vibrations of an average period of 7,2s.

The P.P., whose duration was about 16m, consisted of regular vibrations of an average period of 8,8s, the max. 2a being 0,09 mm. There were several alternations of max. and min. groups; the average interval between successive maxima being 1,5 m.

The E.P. The average period, measured towards the end, was 9,8s.

(NS component).

Th[illegible]. lasted 5m 42s.

[illegible]. The max. 2a was 0,08 mm.

Eqke No. 138. **May 14th 1899; 10h 56m 31s p.m.**

Total duration = 24m.

The beginning was somewhat obscure.

(EW component).

The P.T. lasted for about 5m.

The P.P. consisted of undulations of an average period of 16,7s, superposed with small vibrations of an average period of 5,6s. The max. 2a was 0,05 mm, the group of most active movements occurring at 3¾m from the commencement.

(NS component).

The P.T. lasted about 4m. (?)

The P.P. The average period was about 19s, the max. 2a being 0,05 mm.

Eqke No. 139. May 15th 1899; 9h 57m 53s p.m.

Total duration = 37m.

(NS component).

The P.T., whose duration was 5m 45s, showed traces of vibrations of an average period of 6,4s.

The P.P., whose duration was 9m 0s, consisted of vibrations of an average period of 8,7s, the max. 2a being 0,04 mm.

In the E.P. the motion was very small.

(EW component).

The max. 2a was 0,03 mm.

Eqke No. 140. May 18th 1899; 4h 1m 45s a.m.

Total duration = 30m.

This was a small earthquake at a distance. The motion was very small.

Eqke No. 141. May 26th 1899; 11h 38m 28s p.m.

Total duration = about 13m.

This was a very small earthquake at some distance.

The P.T. lasted for about 51s.

The P.P. The average period was 6,4s. The max. 2a was less than 0,02 mm in each component.

Eqke No. 143. June 5th 1899; 1h 37m 43s p.m.

Total duration = 2h.

This was evidently a large earthquake at a very great distance.

(NS component).

The 1st P.T., whose duration was 17m 25s, began with very small vibrations of 2a less than 0,02 mm. The average period during the first half of this epoch was 5,6s and that during the remaining half was 8,1s.

The 2nd P.T., whose duration was 16m 13s, consisted of well defined regular undulations, the max. 2a of 0,04 mm occurring at the commencement. The average period was as follows:—

10,7s (at the commencement),
10,9 (,, ,, end

The P.P. began very gradually with small slow undulations. After 5m 0s there appeared well defined undulations of an average period of 23,7s, which lasted for 17m 0s. Then followed the maximum group of waves (2a = 0,05 mm), which was somewhat quicker and had an average period of 18,2s.

There was no demarcation between the P.P. and the P.T.

(EW component).

The 1st P.T. lasted 17m 45s.

The 2nd P.T. lasted for 18m 28s, the max. 2a of 0,03 mm occurring at the commencement.

The P.P. The max. 2a was 0,02 mm.

P.O. The amplitude was very small.

Eqke No. 145. June 10th 1899; 3h 35m 20s p.m.

Total duration = about 33m.

The beginning of the motion was somewhat obscure, owing to the existence [illegible]light P.O.

(EW component).

The P.T. lasted for 5m 5s and had an average period of 5,1s. The motion was very small.

The P.P. consisted of small but well defined undulations of an average period of 9,8s; the max. 2a of 0,04 mm occurring near the beginning. The motion showed a series of alternations of max. and min. groups.

(NS component).

The motion was very small.

P.O. The amplitude was very small. Its average period, measured 1h before the earthquake, was 4,3s.

Eqke No. 146. June 13th 1899; 4h 31m 18s a.m.

Total duration = about 26m.

The motion began very gradually and the P.T. was not well defined. The time interval between the assumed commencement and the occurrence of the max. motion was about 1m 25s.

The P.P. lasted about 18m, the max. 2a being 0,05 mm in the EW and 0,04 mm in the NS component. The average period, measured at the commencement, was about 11s.

The E.P. The average period was about 11s.

Eqke No. 147. June 14th 1899; 8h 27m 46s p.m.

Total duration = 1h 24m.

This was a large earthquake at a great distance. The motion began gradually with very small vibrations clearly recorded, there being no P.O.

(NS component).

The 1st P.T., whose duration was 9m 10s, consisted uniformly of small vibrations of an average period of 4,9s.

The 2nd P.T. whose duration was 6m 40s, consisted of larger and somewhat slower vibrations of an average period of 7,1s. The max. 2a was 0,03 mm, the motion being larger at the commencement and end, than at the middle, of this epoch.

The P.P. began with traces of slow undulations. It was only 18m

40s later on that there appeared small but well defined waves, which lasted for 11m 25s and had an average period of 30s. After this the vibrations became gradually most active, and their max. 2a of 0,05 mm occurred at 9h 22m 32; the average period deduced from two successive groups of 50 waves being as follows:—

18,4s	(General mean)
16,4	17,4s.

There were alternations of max. and min. epochs; the max. groups occurring at an average interval of about 4m.

(EW component).

The 1st P.T. lasted for 7m 38s.

The 2nd P.T., whose duration was 8m 45s, had an average period of about 7,4s.

The P.P. began with ill defined traces of slow undulations. 20m 40s later on there appeared small but well defined waves, which lasted for 8m 54s and had an average period of 23,2s. Thereafter the motion increased and quickened, the max. 2a of 0,04 mm occurring at 37m 34s from the commencement of this epoch. The average period of these latter waves, measured from two successive groups of 30 vibrations, was as follows:—

18,8s	(General mean)
17,0	17,9s.

Eqke No. 149. June 16th 1899; 2h 49m 10s p.m.

Total duration = 25m.

This was a small earthquake at some distance.

(EW component).

The 1st P.T., whose duration was 3m 40s, consisted of very small vibrations of an average period of 2,7s.

The 2nd P.T., whose duration was 2m 46s, consisted of traces of waves of an average period of 7,5s, superposed with the small vibrations of the same nature as those in the 1st P.T.

The P.P., began with a group of most active waves, whose max.

(abs.) 2a was 0,06 mm and whose average period was 12,4s. There were alternations of max. and min. epochs, each of which comprised 4 to 6 waves. The average interval between the successive maxima was about 1,9m.

(NS component).

The total duration of the 1st and 2nd P.T.'s was 6m 30s.

The P.P. The max. 2a was 0,02 mm.

Eqke No. 152. June 19th 1899; 9h 2m 22s p.m.

Total duration = 31m.

This was a small earthquake at some distance.

The P.T., whose duration was 3m 38s, consisted of very small vibrations of an average period of 5,0s.

The P.P. The max. 2a of 0,04 mm in the EW and 0,03 mm in the NS component occurred at 9m from the beginning of the earthquake. The average period was 7,9s.

Eqke No. 153. June 24th 1899; 11h 46m 3s a.m.

Total duration = 15m.

This was a very small earthquake at some distance.

The maximum epoch, which lasted for about 6m, commenced at 4m 10s after the beginning of the earthquake. The average period was 7,3s.

Eqke No. 154. June 25th 1899; 1h 12m 28s a.m.

Total duration = 33m.

This was a small earthquake at a great distance, and the motion began gradually with very small vibrations.

(NS component).

The P.T. lasted for 14m 52s and consisted of small vibrations of an average period of 7,8s, the amplitude being rather greater at the commencement than at the end.

The P.P. For the first 1m 20s the motion was small. For the next 8m 55s the waves were well defined, the max. 2a being 0,08 mm and the average period 15,7s. These waves were distributed into 6 max. and

min. groups, the average interval between the successive maxima being 1,5m.

(EW component).

The P.T. lasted for about 19m 55s, the motion being very small.

The P.P. For the first 2m, the motion was small. Then followed well defined vibrations, which lasted for 11m, and whose average period was, during the earlier 5¼m, 16,5s and, during the remaining 6m 12s, 12,4s. The max. 2a of 0,04 mm occurred at about 6m from the commencement.

Eqke No. 155. June 25th 1899; 2h 25m 42s a.m.
Total duration = 36m.

This was a small earthquake at a great distance and the motion began very gradually.

The P.T., whose duration was 19m 55s, consisted of very small vibrations with an average period of 9s.

The P.P., whose duration was 7m 35s, had an average period of 16,8s, the max. 2a being about 0,04 mm in each component.

The E.P. The average period was 11s.

Eqke No. 156. July 4th 1899; 0h 44m 11s a.m.
Total duration = 24m.

This was a small earthquake at some distance.

The P.T., whose duration was 3m 44s, consisted of traces of very small undulations of an average period of about 4,3s.

The P.P., whose duration was 3m, had an average period of 7,5s. The max. 2a was 0,03 mm in each component.

The E.P. The average period was 9,5s.

This earthquake was observed at the Meteorological Observatories of Kagoshima and Ōshima as follows:—

Kagoshima	0h 42m 58s a.m.	Slight.	Motion gentle.
Ōshima ..	0. 40. 0	„	Houses shaken.

Eqke No. 162. July 12th 1899; 11h 56m 26s p.m.

Total duration = 1h 25m.

(NS component).

The P.T., whose duration was 3m 51s, had an average period of 7,3s, there being also traces of small vibrations of an average period of 4,8s. The amplitude was slightly greater in the earlier than in the later part, the max. 2a being 0,16 mm.

The P.P., whose duration was about 7m, began with the max. 2a of 0,34 mm. During the first 1m 14s, when the motion was most active, the average period was 10,6s. Then followed quicker vibrations (max 2a = 0,25 mm) of an average period of 6,8s.

The E.P. The average period was as follows:—

8,2s (at the commencement),

10,1 (1h after the beginning of the earthquake).

(EW component).

The P.T. lasted 3m 45s, the max. 2a being 0,14 mm. The average period was 6,2s, there being also traces of smaller vibrations.

The P.P., whose duration was 5m 24s, began with the max. 2a of 0,5 mm. During the first 1m 31s the average period was 11,4s. Towards the end (max. 2a = 0,3 mm) the average period was 7,3s.

The E.P. The average period was as follows:—

8,5s (at the commencement),

10,0 (1h after the beginning of the earthquake).

Eqke No. 163. July 14th 1899; 9h 6m 3s p.m.

Total duration = 3h.

This was a large earthquake at some great distance. The beginning of the motion is clearly defined, the very first displacement being 0,05 mm towards E and 0,1 mm towards N, followed by a decided counter displacement of 0,55 mm towards W and 0,5 mm towards S.

(EW component).

The P.T. Throughout this epoch, which lasted for 8m 28s amplitude

not much vary. There was, however, a slight increase in amplitude at 2m 47s from the commencement, denoting probably the appearance of the 2nd P.T. The motion consisted of vibrations (max. 2a=0,6 mm) of an average period of 6,2s, superposed on slower and larger undulations (max. 2a=0,8 mm) of an average period of 14,2s. It is to be noted that in this case the motion was active from the very beginning of the P.T., which did not consist of small vibrations as generally happens.

The P.P., whose duration was 6m 40s, began with three slow undulations of an average period of 30s, superposed with small vibrations of an average period of 7,0s. Then followed 4 well defined waves, which together occupied 2m 10s and had an average period of 33s. Of these, the 3rd vibration, which was the absolute maximum (2a=6,6 mm), occurred at 2m 32s from the commencement. The next three waves had an average period of 31s.

The E.P. showed occasional alternations of maximum and minimum epochs. The average period, deduced from 3 groups of 80 vibrations was as follows:—

9,9s	(in the earlier part),	
9,0	(at about 1h after the beginning of the eqke),	
9,6	(„ „ 2hs „ „ „).	

(NS component).

The 1st P.T., whose duration was 2m 48s, consisted of vibrations (max. 2a=0,75 mm) of an average period of 15s, superposed with others (max. 2a=0,02 mm) of an average period of 7,1s. The amplitude remained nearly constant.

The 2nd P.T., whose duration was 4m 16s, began with a prominent (max.) displacement of 1,45 mm, and consisted of vibrations of an average period of 10,7s, superposed with others of an average period of 5,7s. There seemed to exist also traces of still quicker vibrations.

The P.P., whose duration was about 9m 20s, began with a well defined vibration of (2a=1,5 mm), the succeeding 4 vibrations having smaller amplitude and an average period of 20s. The most active part

of the P.P, began at 1m 38s after its commencement and lasted for 3m 0s, consisting of 12 undulations of an average period of 15s. The absolute max. 2a of 3,2 mm occurred at 9h 16m 26s p.m. Later on the motion consisted of regular vibrations of an average period of 9,4s.

The E.P. The average period deduced from three groups of [illegible] vibrations was as follows :—

9,3s (in the earlier part; these being superposed on undulations of an average period of 15,8s),

9,4 (1h after the beginning of the eqke),

9,0 (2hs „ „ „ „ „).

General mean.... 9,2s.

Eqke No. 165. July 17th 1899; 1h 59m 23s p.m.

Total duration = 2h 2m.

This was a large earthquake at a distance.

(EW component).

The P.T., whose duration was 4m 45s, had an average period of 45s.

The P.P., whose duration was 10m 30s was characterized by the appearance of slow undulations. During the first 1m 45s the motion was ill defined. During the next 5m 8s, however, there appeared a max. group, consisting of 15 conspicuous waves of an average period of 20s. These were superposed with small vibrations of an average period of 5,6s. After this predominated waves of an average period of 12,8s, which lasted for 3m 50s, and of which the last 1m 38s interval formed the most active portion of the earthquake, the max. 2a of 0,15 mm occurring at 2h 13m 4s.

The E.P. The average period deduced from two groups of 50 vibrations, was as follows :—

11,3s (at the commencement),

10,0 (towards the end).

There were some alternations of max. and min. epochs.

(NS component).

The 1st P.T. was well defined and lasted for 4m 12s. In the earlier

part predominated small vibrations of an average period of 3,6s, while in the later part predominated those of an average period of 5,9s.

The 2nd P.T., whose duration was 2m 30s, began with well defined small vibrations, whose max. 2a was 0,05 mm, and whose average period was 6,5s.

The P.P. began with 15 slow undulations, which lasted for 4m 58s and had an average period of 20s. These were followed by quicker active vibrations, which began with the (abs.) max. 2a of 0,06 mm and had an average period of 13,7s.

Eqke No. 166. July 17th 1899; 7h 48m 2s p.m.
Total duration = about 29m.

This was a small earthquake at a distance.

The P.T. lasted for about 3m 40s.

The P.P. The max. 2a was 0,02 mm in each component. The average period was 17,4s.

Eqke No. 168. July 21st 1899; 7h 25m 55s a.m.
Total duration = about 18m.

This was a small earthquake at some distance and the motion consisted mainly of regular vibrations.

(NS component).

The P.T., whose duration was about 1m 28s, had the max. 2a of 0,04 mm and an average period of 3,0s, there being also traces of slow undulations.

The P.P. consisted of a great number of nearly similar vibrations, whose average period was 4,2s. The max. 2a of 0,07 mm occurred at about 6m from the beginning of the earthquake.

The E.P. The average period, measured towards the end, was 6,3s.

The EW component diagram was not obtained, as the earthquake took place during the change of the record-receiver of that component apparatus.

Eqke No. 169. July 24th 1899; 10h 23m 33s a.m.
Total duration = 1h 45m.

This was a large earthquake at a great distance.

(NS component).

The P.T. lasted for about 3m 19s and had an average period of 12,4s.
(The beginning was slightly confused by the presence of small P.O.)

The P.P., whose duration was 21m, began with a group of vibrations which formed the most active part of the motion, the max. 2a being 0,18 mm. Thereafter the motion remained nearly constant in amplitude, except for altermations of max. and min. epochs. The average period, deduced from three successive groups of 30 vibrations, was as follows:—

9,7s
10,3
10,4
(General mean) 10,1s...... (measured near the commencement of the P.P.)

The E.P. The average period deduced from three successive groups of 30 vibrations taken at about 1h after the commencement of the earthquake was as follows:—

10,3s
10,1
9,0
(General mean) 9,8s.

(EW component)

The P.T. lasted for about 3m 0s, the motion being very small.

The P.P. The max. 2a of 0,1 mm occurred at the commencement. The first 17 undulations which together occupied an interval of 3m 46s, and had an average period of 13,3s, formed the most active part of the motion. Then followed regular and somewhat quicker vibrations (max. 2a = 0,1 mm), whose average period, deduced from three successive groups of 30 vibrations was as follows:—

10,3s
9,9
10,8
(General mean) 10,3s.

Eqke No. 171. July 29th 1899; 6h 22m 16s a.m.

Total duration = 20m.

This was a small earthquake at a comparatively great distance. The beginning of the motion was somewhat obscure on account of the presence of P.O.

(EW component).

The P.T. was not well defined, but the motion began with small vibrations of an average period of 7,8s. The max. 2a of 0,05 mm occurred at 3m 10s from the commencement.

(NS component).

The max. 2a was 0,02 mm.

P.O. The average period, measured immediately before the earthquake, was 3,8s.

Eqke No. 172. July 30th 1899; 4h 44m 6s a.m.

Total duration = 41m.

This was a very small earthquake at some distance.

(NS component).

The motion began gradually and the P.T. was not well defined.

Near the beginning the average period was 7,0s. In the most active part of the motion, at about 16m from the commencement, it was 14s. The max. 2a was 0,02 mm. (The EW component diagram was lost by accidence.)

Eqke No. 173. July 31st 1899; 1h 30m 11s a.m.

Total duration = about 22m.

This was a small earthquake at some distance.

The P.T. was not well defined, the motion gradually becoming larger. The max. 2a was 0,04 mm in the EW and 0,02 mm in the NS component. The average period was as follows :—

7,4s (at the commencement of the P.P.),
7,9 (in the most active part of the P.P.),
8,0 (near the end of the earthquake).

Eqke No. 177. August 4th 1899; 1h 50m 2s p.m.

Total duration = 2h 19m.

This was a large earthquake at a great distance.

The beginning, the 1st and 2nd P.T.'s, and the P.P. were all clearly defined.

(EW component).

The 1st P.T., whose duration was 6m 6s, began with small waves of an average period of 2,6s, superposed on slower vibrations of an average period of 9,1s. After 2m 26s there appeared well defined vibrations of an average period of 7,0s, whose max. 2a of 0,4 mm occurred 1m 50s later on. This maximum motion was, however, by no means a prominent one, the amplitude remaining sensibly constant throughout this epoch except at its commencement.

The 2nd P.T., whose duration was 3m 25s, consisted of well defined vibrations (which were not at all small tremors) of an average period of 6,0s, superposed more or less distinctly on slower waves of an average period of 13,6s. There existed also some ill defined traces of still slower undulations.

The 2nd P.T. began with its maximum vibration whose period was 14s and whose first and second displacements were as follows:—

(1st displ.)	1,28 mm	towards	E,
	0,6 ,,	,,	S.
(2nd displ.)	2,2 mm	,,	W,
	1,04 ,,	,,	N.

The resultant ranges of these two displacements were respectively 1,4 mm and 2,4 mm, their directions being S 65° E and N 62° W.

The P.P. lasted for 5m 20s and began with two slow undulations whose 2a was 1,7 mm and whose period was 32s. Then followed two large proper pendulum oscillations of an average period of 28s, their maximum 2a of 12,4 mm occurring at 2h 1m 14s. After these there appeared four slow undulations of an average period of 37s, the first of

which had a max. 2a of 4,7 mm. The succeeding mation was very much smaller.

The E.P. consisted of regular simple waves. The average period, deduced from two successive groups of 100 vibrations taken at 45 m after the commencement of the earthquake was as follows :—

$$\left.\begin{array}{l} 9{,}3s \\ 8{,}8 \end{array}\right\} \begin{array}{c} \text{(General mean)} \\ 9{,}1s. \end{array}$$

There were no marked alternations of max. and min. movements.

(NS component).

The 1st P.T., lasted for 6m 8s and began with a vibration whose 2a was 0,3 mm and whose period was 10,9s. The motion consisted essentially of vibrations whose average period was 9,7s and whose max. 2a of 0,46 mm occurred near the middle of this epoch. There were also traces of smaller vibrations of an average period of 5,6s.

The 2nd P.T. began with the maximum vibration and lasted for 3m 45s, the motion consisting essentially of waves of an average period of 13,3s, superposed with others of an average period of 6,5s. The 2nd P.T. was in this case not at all a tremor, its amplitude being nearly equal to that in the P.P. which followed it.

The P.P. lasted for about 11m 15s. The max. (abs.) 2a of 1,9 mm occurred at 2h 2m 16s, its period being 13,9s. The average period, measured towards the end of this epoch, was 16,4s. There were also traces of some slow undulations.

Eqke No. 185. August 14th 1899; 8h 55m 20s p.m.

Total duration = about 6m 30s.

This was probably a distant earthquake, and the diagram showed traces of small slow movements of an average period of 9,5s, superposed with quicker vibrations.

Eqke No. 186. August 18th 1899; 5h 46m 31s a.m.

Total duration = 1h 10m.

This was an earthquake at a great distance.

The motion began with very slight vibrations, but the commencement was clearly recorded. The 1st and 2nd P.T.'s as well as the P.P. were also well defined.

(EW component).

The 1st P.T. lasted for 9m 15s, the amplitude, which was very small, remaining nearly constant. The average period was about 8,3s.

The 2nd P.T., whose duration was 16m 30s, had an average period of 9s. The amplitude remained nearly constant throughout this epoch or rather the first half portion had a slightly greater amplitude than the second half. The max. 2a was 0,05 mm.

The P.P., lasted for 15m and consisted of well defined vibrations of an average period of 13,8s, whose max. 2a of 0,35 mm occurred at 6h 15m 28s.

The E.P. The average period deduced from two successive groups of 50 vibrations was as follows:—

$$\left.\begin{array}{l}10{,}5\text{s}\\11{,}9\end{array}\right\}\quad\begin{array}{c}\text{(General mean)}\\11{,}2\text{s.}\end{array}$$

(NS component).

The 1st P.T. lasted for 7m 25s.

The 2nd P.T. lasted for 16m 50s and had an average period of 8,6s, the max. 2a being 0,05 mm. The motion was most active at the commencement, but practically nil towards the end.

The P.P. whose duration was 13m had an average period of 13,5s. The motion presented a series of alternations of max. and min. epochs, there being, in particular, five conspicuous maximum movements which occurred respectively at 6h 11m 46s, 6h 14m 18s, 6h 16m 53s, 6h 19m 13s and 6h 21m 23s. The fourth was the absolute maximum, its 2a being 0,35.mm.

The E.P. The average period deduced from two successive groups of 50 vibrations taken at the commencement was as follows:—

$$\left.\begin{array}{l}12{,}3\text{s}\\12{,}2\end{array}\right\}\quad\begin{array}{c}\text{(General mean)}\\12{,}3\text{s.}\end{array}$$

P.O. The amplitude was very small. The average period, measured the before the commencement of the earthquake, was 4,2s.

Eqke No. 187. August 21st 1899; 1h 11m 44s a.m.

Total duration = about 22m.

This was a small earthquake at a great distance. The motion was very small.

(NS component).

The P.T. lasted for 7m 55s and consisted of very small vibrations of an average period of 7,1s.

The P.P. consisted of a great number of nearly similar regular vibrations of an average period of 10,5s. The max. 2a was 0,025 mm.

(EW component).

The motion was much smaller than in the NS component.

Eqke No. 188. August 25th 1899; 0h 20m 7s a.m.

Total duration = 1h 10m.

This was a large earthquake at a great distance. The commencement was clearly recorded and the 1st and 2nd P.T.'s as well as the P.P. were well defined.

(NS component).

The 1st P.T. lasted for 9m 0s. During the first 4m the motion was small, the max. 2a being 0,05 mm and the average period 4,8s. In the remainder of this epoch, the amplitude was nearly the same as before, but the average period was lengthened to 10,4s.

The 2nd P.T., whose duration was 8m 33s, began with a group of 9 most active movements, occupying together 1m 29s. Their average period was 9,9s and the max. 2a of 0,22 mm occurred near the end of the series. The following motion consisted of uniform regular vibrations, which decreased towards the end, the average period being 7,0s.

The P.P., whose duration was 12m 20s, began gradually with small slow undulations. During the first 8m 55s, the average period was 27s, the amplitude becoming somewhat prominent first at 6m 0s after the

commencement of the P.P. At 0h 46m 26s appeared 4 well defined waves, which formed the most active part of the motion and whose 3rd vibration had a max. 2a of 0,2 mm; their average period was 22s. The following movements were much smaller, their average period being 19,4s.

The E.P. here comprises the part of the motion whose amplitude was not at all small, but whose period was somewhat quicker than in the P.P. The average period deduced from two successive groups of 50 vibrations (taken at the commencement) was as follows:—

17,9s	}	(General mean)
16,5		17,2s.

The motion showed a series of alternations of max. and min. vibrations there being, during the first 30m, 9 max. and 9 min. groups.

(EW component).

The 1st P.T. lasted for 10m 5s. During the first 3m 35s, the motion was small, the max. 2a being 0,03 mm; the average period was 4,3s. The following vibrations had an average period of 6,9s, the max. 2a being 0,06 mm.

The 2nd P.T., whose duration was 10m 5s, had an average period of 8,9s. The amplitude was greater at the beginning than at the end. The max. 2a of 0,15 mm occurred at 0h 32m 57s.

The P.P. The max. 2a was 0,08 mm, the motion being smaller in this than in the NS component.

Eqke No. 189. August 26th 1899; 7h 7m 11s a.m.

Total duration = about 20m.

This was a small earthquake at some distance.

The commencement was somewhat obscure, but the 2nd P.T., and the P.P. were well defined.

(EW component).

The 1st P.T. lasted about 42s.

The 2nd P.T. lasted for 1m 13s and consisted of small but distinct

vibrations of an average period of 2,6s. The amplitude remained nearly constant, or rather slightly decreased towards the end.

The P.P. lasted for 3m 46s and began with 5 principal undulations whose average period was 10,9s; the 3rd vibration having the maximum 2a of 0,2 mm in the EW and 0,12 mm in the NS component. The remaining portion had an average period of 9,0s. The motion showed in the EW component three alternations of max. and min. movements, the maximum occurring respectively at 2m 19s, 3m 33s and 4m 59s from the commencement of the earthquake.

The E.P. The average period, deduced from three successive groups of 50 vibrations, was as follows:—

$$\left.\begin{array}{l} 7{,}1\text{s} \\ 7{,}0 \\ 7{,}4 \end{array}\right\} \begin{array}{c} \text{(General mean)} \\ 7{,}2\text{s} \end{array}$$

(NS component).

The P.T. lasted about 2m 36s.

Eqke No. 190. August 26th 1899; 1h 58m 29s p.m.
Total duration = about 20m.

This was a small earthquake at some distance. The diagram is very similar to that of the preceding earthquake No. 189.

The 1st P.T. lasted for 1m 11s.

The 2nd P.T. lasted for 1m 2s and consisted of well defined quick vibrations of an average period of 3,1s. The max. 2a was 0,03 mm in each component.

The P.P. lasted for 3m 32s and began with four well defined large vibrations of an average period of 10,1s; of these the last movement was the maximum, its 2a being 0,18 mm in the EW and 0,17 mm in the NS component. The succeeding waves had an average period of 9,2s. The motion showed in the EW component three maximum groups, occurring respectively at 2m 49s, 4m 2s and 5m 33s after the commencement of the

earthquake. Such an alternation of the max. and min. movements was not indicated in the NS component.

The E.P. The average period deduced from two successive groups of 50 vibrations was as follows:—

7,8s } (General mean)
7,2 } 7,5s.

Eqke No. 193. September 4th 1899; 9h 31m 59s a.m.
Total duration = 3h.

This was a very large earthquake and originated, as eqkes Nos 196 and 197, off the south-west coast of Alasca. The following extract is taken from the *Japan Times* of October 31st 1899.—

A big Alascan Earthquake.

Port Townsend (Wash.) Sept. 24.—Concerning the recent earthquakes along the coast of Alasca, the reverend Sheldon Jackson, United States Educational Agent for Alasca, writes as follows from Yakutat under date of Sept. 17th.

„ The first shock was experienced on Sunday, Sept. 3rd, but being slight, caused no alarm. During the following week other shocks were felt, and people began to get nervous. On Sept. 10th, at 9.20 a.m. shocks became so violent as to cause genuine apprehension. During the following five hours there were fifty-two distinct shocks, culminating at 3 p.m. in a shock so severe that the people of Yakutat were hurled violently across their rooms, or, if outside, thrown to the ground, while pictures fell from the walls and clocks and dishes crashed from the shelves and houses rocked and swerged and whirled, while the mission bell rang violently in the Skakine Church tower.

„ Painc stricken, the inhabitants regained their feet and attempted to flee to the hills, only to be again thrown to the earth, all the while creaking. Gaining the hills and looking seaward, they were transfixed with horrow as they saw a great tidal wave apparently a wall of

water 30 feet high, approaching with the speed of a race horse, that would engulf their village and sweep away their homes. Before the shore was reached the earth opened in the bottom of the harbour and into this chasm the tidal wave spent its force, and around it the sea swelled like a great maelstrom. This seaved the village from destruction.

„ The tide would rise ten feet in the space of four or five minutes and in an equally short time go down again. These sudden fluctuations being frequently repeated, tents were pitched on the hills back of the village and nearly the whole population are camping out, fearing that another tidal wave may come. From the 10th to the present time there have been frequent shocks, one having occurred this forenoon............ Great spruce forests for miles along the shore were uprooted, broken into pieces and massed into great piles with a roar that was deafening. Large rocks weighing fourty tons or more were rolling over one another down the mountain like so many pebbles. Hubbard glacier, with its two and a half miles of sea front, thousands of feet thick, extending for miles back to the summit of the mountain, broken from its moorings and with a grinding indescribable roar that shook the surrounding hills moved bodily from half to three-quarters of a mile into the sea. Mountains were thrown down, the sea opened and portions of islands disappeared..........

„ Rumours are afloat that a portion of Cape St. Elias and Khantaak island have disappeared in the sea..

(EW component).

The 1st P.T., whose duration was 7m 36s, consisted of vibrations of an average period of 7,9s (max. 2a=0,25 mm), superposed with still smaller ones of an average period of 3,5s (max. 2a=0,15 mm). There were also traces of slow undulations of an average period of 18s. The commencement was small and gradual, but distinct, the amplitude remaining on the whole constant.

The 2nd P.T., lasted for 9m 38s and began with a motion of 0,46 mm

towards W followed by a well pronounced undulation whose period was 34s and which consisted of the two displacements :—

(1st) 2,5 mm towards E,
(2nd) 4,1 „ „ W.

For the next 6m 12s the amplitude did not much vary and was slightly smaller than that of the above introductory wave the average, period being 25,2s. After these, took place two conspicuous undulations of an average period of 34,5s, the first of which had the max. 2a of 5,6 mm. There were also traces of slow undulations with an average period of 1m 6s. It is to be remarked that the 2nd P.T. was in this case not at all a small insignificant tremor but consisted of large well defined waves.

The P.P. lasted for 22m, and began with seven large undulations which together occupied 3m 48s and had an average period of 32,6s; the second having the max. (abs.) 2a of 15,2 mm. These vibrations, which were apparently produced by the composition of the proper oscillations of the pendulum with the earthquake motion, were arranged as follows :—

1st motion : 5,5 mm towards W,
2nd „ : 11,3 „ „ E ;
then followed the max. motion above noted ;
the next vibration was a little smaller ;
the two next ones were small ;
then followed the second max. 2a of 13,8 mm.

After these the motion became quicker, the average period during the next 4m 42s being 23,5s. For the next 4m 51s the motion consisted of well defined vibrations, whose max. 2a was 4,8 mm and whose average period 16,2s. During the remaining part the average period was 14,9s.

The E.P. For the first 26m the motion was more or less large, the average period of the principal vibrations being 16,2s. There were also traces of slower undulations of an average period of 51s and of others of an average period of 24s. During the next 12m 30s, the principal waves had an average period of 20,8s, superposed with smaller vibrations. From

about 1h 45m after the commencement of the earthquake, the motion consisted essentially of regular. waves, whose average period, deduced from three successive groups of 50 vibrations, was as follows :—

10,4s	}	(General mean)
10,9	}	10,5s.
10,3	}	

Eqke No. 196. September 11th 1899; 3h 14m 16s a.m.

Total duration = about 3h.

(EW component).

The 1st P.T. lasted for 7m 38s and consisted of small vibrations of an average period of 6,8s.

The 2nd P.T. lasted for 6m 53s.

The P.P. The max. 2a was 2,6 mm and the average period was 32s.

The E.P. The average period, measured at about 1h after the commencement of the earthquake, was 10,4s.

Eqke No. 197. September 11th 1899; 6h 50m 58s a.m.

Total duration = 4h.

This was a very large earthquake and, like the two preceding ones, originated off the south-western coast of Alasca. It appears that, at the origin, shocks happened almost continuously after the eqke No. 196, the diagram showing more or less distinct traces of motion throughout the time interval between the latter and this earthquake.

(EW component).

The 1st P.T., whose duration was 7m 43s, consisted of small vibrations of an average period of 4,3s, superposed on larger ones of an average period of 9,3s.

The 2nd P.T., whose duration was 6m 30s, began with a well defined displacement of 2 mm towards E, followed by 14 large undulations with an average period of 27s,

The P.P., whose duration was about 15m, began with four very slow undulations with an average period of 41s. Then followed five large

proper oscillations of the pendulum, their max. 2a being 10,5 mm. The average period, measured at about 23m from the commencement of the earthquake, was 24s.

The E.P. The average period, measured at respectively 1h, 2h and 3h after the commencement of the earthquake, was as follows:—

9.9s	(deduced from 57 vibrations),	(General mean) 9,8s.
9,8	(„ „ 100 „),	
9,7	(„ „ 60 „),	

It will be observed that in the three foregoing earthquakes, Nos. 193, 196, and 197, the 1st P.T. lasted for an almost exactly identical interval of time. This shows that these earthquakes originated very nearly at an equal distance from Tokyo. Assuming the position of their centres to be near the Cape St. Elias, the spherical distance between it and Tokyo would be about 6100 km.

Eqke No. 198. September 11th 1899; 8h 44m 35s p.m.
Total duration = about 19m.

This was a small earthquake at some distance. There were small P.O.

(EW component).

The 1st P.T., whose duration was 2m 5s, consisted of small vibrations of an average period of 3,9s, superposed on slower ones of an average period of 9,2s.

The 2nd P.T., whose duration was 1m 36s, commenced with the max. 2a of 0,08 mm. The motion consisted of well defined vibrations of an average period of 9,6s, superposed with smaller ones of an average period of 3,7s.

The P.P., whose duration was 3m 48s, consisted of regular well defined vibrations. The first 12 waves, which together occupied 1m 48s, had an average period of 9,0s and were of nearly an equal amplitude; the 2nd vibration having a max. 2a of 0,16 mm. The motion then remained

small for 43s, but was again increased for the next 1m 10s, the maximum 2a being 0,14 mm and the average period 9,2s.

The E.P. showed at first some insignificant alternations of max. and min. movements. The average period was 7,6s.

(NS component).

The max. 2a was 0,1 mm.

P.O. The average period, measured immediately after the earthquake, was 4,6s.

Eqke No. 200. September 17th 1899; 10h 1m 8s p.m.

Total duration = 2h.

This was an earthquake at a great distance.

The P.T. lasted for about 9m 20s.

The P.P. consisted of small regular vibrations of an average period of 8,7s. The max. 2a was 0,05 mm in the EW and 0,02 mm in the NS component.

Eqke No. 201. September 20th 1899; 11h 24m 27s a.m.

Total duration = 1h 15m.

This was the great Smyrna Earthquake. The *Japan Times* of November 12th had the following article.—

„ Constantinople, October 2.—It is now estimated that 1500 Persians perished in the earthquakes in Asia Minor, around Aidin. The first shock occurred at 4 o'clock in the morning of September 20th and lasted 40 seconds. The effects were appalling. Whole villages were completely destroyed. The earthquake was felt as far as Scio, Mitylene and Smyrna.

„ The latest advices from the stricken area show that men, women and children were buried in the ruins of their dwellings before they realized their danger. Numbers of bodies still lie beneath the debris. About 500 persons were killed at Sarakeni and some 500 at Denizli, where three-fourths of the buildings fell. There was proportionate loss of life in many of the smaller villages. The distur-

bance has not yet subsided, although its strength appears to be spent. The shocks continue almost daily, but with no great violence. The population is encamped in the open.

„ One consequence of the earthquake is the subsidence of the level of the Aidin district by two yards. Sulphurous springs burst out in the valley of Noander and the country between Aidin and Denizli became full of crevices, out of which rushed black, muddy water with sufficient volume to wash away a flock of 1000 sheep.

„ The villagers of the Valley of Noander report that for several days previous to the catastrophie domestic animals were greatly disturbed, bleeting and barking."

Assuming the origin of the earthquake to be in the vicinity of Denizli, the distance between it and Tokyo would be 82° 26′ or 9200 km along the great circle. The time of occurrence of the earthquake in Tokyo is, when referred to the meridian of Smyrna, about 4h 12m a.m.

(EW component).

The 1st P.T. lasted for 10m 19s and consisted of small vibrations of an average period of 6,0s, superposed more or less distinctly on traces of slower waves of an average period of 8,7s.

The 2nd P.T. lasted for 12m 0s and consisted of well defined vibrations of an average period of 10,5s, superposed with some minute vibrations.

The P.P. lasted for 21m. For the first 12m the motion consisted of very slow undulations, whose period was 42s, superposed with some small vibrations. After this, the movements became quicker, the average period deduced from two successive groups of 40 vibrations being as follows:—

$$\left.\begin{array}{l}16{,}5\text{s}\\14{,}5\end{array}\right\}\begin{array}{c}\text{(General mean)}\\15{,}5\text{s.}\end{array}$$

The max. 2a of 0,9 mm (period 16,7s) occurred at 41 m after the commencement of the earthquake.

P.O. In the early morning of the 22nd the P.O. became prominent. Their average period deduced from three successive groups of 50

vibrations about 5h after the commencement of the earthquake, was as follows :—

$$\left.\begin{array}{l}5{,}6\text{s}\\5{,}7\\5{,}8\end{array}\right\}\begin{array}{c}\text{(General mean)}\\5{,}7\text{s.}\end{array}$$

Their max. 2a was 0,06 mm. [The NS component diagram was not satisfactorily registered, as the sharp conical point (the point of support) of the strut of the horizontal pendulum was damaged, indicating thereby only the proper oscillation of the latter.]

Eqke No. 202. September 23rd 1899; 8h 26m 22s p.m.

Total duration = about 24m.

There were some doubtful traces of a small earthquake at a distance. The record was confused by strong P.O.

Eqke No. 203. September 23rd 1899; 11h 8m 45s p.m.

Total duration = about 28m.

This was an earthquake at a distance. The diagram was somewhat confused by a strong storm of P.O.

(NS component).

At about 7m 30s from the commencement there appeared traces of slow undulations of an average period of 22s, whose max. 2a was 0,07 mm in the NS and doubtful in the EW component.

P.O. The average period was 8,0s, and their max. 2a was 0,05 mm in each component.

Eqke No. 205. September 28th, 1899; 3h 58m 14s p.m.

Total duration = about 19m.

This was a small earthquake at some distance. The P.T. was not well defined.

The max. 2a, which occurred at 4m 45s after the commencement, was 0,04 mm in the EW and 0,05 mm in the NS component. The average period was about 6,4s.

P.O. There were very small and quick P.O. whose average period, measured a few hours before the earthquake, was 3,4s.

Eqke No. 206. September 29th 1899; 8h 40m 28s p.m.
Total duration = 17m.

This was a small earthquake at a distance.

The P.T., whose duration was about 2m, had an average period of 3,3s.

The P.P. whose duration was about 4m had an average period of 8,9s; the max. 2a being 0,1 mm in each component.

Eqke No. 207. September 30th 1899; 2h 11m 0s a.m.
Total duration = 1h 30m.

This was the great earthquake which caused much damage along the south coast of the Ceran Island and in the Molluccas. The following extract is taken from Dr. J.P. van der Stok's paper, entitled "Two earthquakes, registered in Europe and at Batavia."*

1. In the night of 29 to 30 September 1899, a heavy earthquake caused serious damage at the south coast of the isle of Ceram and in the Molluccos.

„ The first official report, sent by the Resident of Amboina to the Governor-General immediately after the disaster, runs as follows:

„ In the night of 29 to 30 September at 1h 45m a.m. a heavy earthquake, followed by a series of sea-waves, caused considerable damage at the south coast of Ceram and, in a less degree, also at the isles of Ambon, Banda and the Ulias-isles. Several villages at Ceram's south coast have been devastated; in the Elpaputih-Bay all except two. The prison at Amahei has been completely destroyed, the fortifications partially, whereas the presbytery and the churches remained unhurt, as also the garrison and the civil officers at Amahei and Kairatoe.

* Koninklijke Akademie van Wetenschappen te Amsterdam. December 20 189

„ As the Government steamer Arend proved incapable of doing all the work, the steamers Gouverneur-General's Jacob and Japara of the Royal Pakketvaart-Company were chartered in order to convey victuals and medical assistance and for the transport of the wounded, whilst also the Resident of Ternate was requested to give assistance. Provisions and material for building are to be had at Ambon in sufficient quantities and have been provided immediately; but in other respects there is still much sufferance.

„ The steamers Jacob brought over to Amboina 27 wounded, whilst the Japara, by which boat the Resident and first medical officer went to the place of the disaster, conveyed 49 wounded from Amahei and Saparna.

„ From Banda, where the pier before fort Nassau has been destroyed, satisfactory information has been received.

„ According to preliminary reports the number of natives, killed by the disaster, amounts to 4000 and that of the wounded to 500.

„ The natives who survived have fled to the inland country and do not venture to come back to their hamlets: there is much agitation everywhere, where the effect of the earth and sea waves has been felt. The petroleum establishment at Bulobay has not suffered any damage."

2. The seismograms, received from Dr. Figee, show that this earthquake has been registered very neatly at the Royal Observatory at Batavia.

As far as I know this is the first case that an earthquake, originating in the Molluccos has been observed at Batavia by means of Milne's seismograph. The motion commences abruptly at 0h 14,6m Batavia time, which corresponds to 1h 43,3m local time, the difference in longitude between Amahei and Batavia being 1h 28,7m.

If we assume the origin of the earthquake to have been situated off the southern coast of the Island of Ceram, at a point long. 129° E, lat. 6° S, the distance along the great circle between the origin and Tokyo would be 4800 km, and that between the origin and Batavia about 1950 km.

(EW component).

The 1st P.T., whose duration was 5m 46s, consisted of vibrations of an average period of 8,9s, superposed with smaller ones of an average period of 3,6s.

The 2nd P.T., whose duration was 3m 39s, consisted of vibrations of an average period of 8,4s, superposed more or less distinctly on traces of slow undulations.

The P.P. lasted for about 10m and began with the conspicuous maximum undulation, whose period was 33s, and whose two displacements were as follows:—

(first motion) 3,3 mm towards W.
(second „) 5,4 „ „ E.

The undulations which followed this maximum were far smaller than the latter, their average period being 20s.

The E.P. The average period, measured at about 1h after the commencement of the earthquake, was 12s.

The NS component of this earthquake as well as of the following was not satisfactorily recorded, on account of the same circumstance as with eqke No. 201.

Eqke No 210. October 4th 1899; 5h 56m 22s p.m.
Total duration = 1h 5m.

(EW component).

The P.T., whose duration was 2m 0s, consisted of small vibrations of an average period of 2,9s.

The P.P. lasted for about 10m and began with eight slow undulations which together occupied 2m 10s and had an average period of 16,3s; the third vibration having the max. 2a of 0,2 mm. Then followed for the next 7m 55s well defined and quicker vibrations of an average period of 11,9s. There were also traces of small movements of an average period of 4,1s, these being recognizable till 8m after the commencement of this epoch.

The E.P. The average period, deduced from three successive series

of 50 vibrations, taken at 30m after the beginning of the motion, was as follows:—

8,9s
9,4 } (General mean) 9,4s.
9,9

(NS component).

The P.T. lasted for about 2m 0s.

The P.P. For the first 2m 45s, the motion consisted of ten slow undulations of an average period of 16,5s; the fourth vibration having the max. 2a of 0,25 mm. Then followed quicker waves whose max. 2a was 0,2 mm and whose average period was 11,6s. In the earlier part of this epoch there were also traces of small quick movements.

P.O. P.O. became strong from about 9 p.m. (Oct. 4th), the maximum motion being 0,05 mm in each component. The average period, measured 13h after the commencement of the earthquake, was 6,7s.

Eqke No. 211. October 5th 1899; 5h 24m 49s a.m.

The diagram showed traces of a small earthquake at some distance, obscured by strong P.O. The max. 2a was about 0,05 mm in each component.

Eqke No. 217. October 14th 1899; 0h 38m 5s a.m.

Total duration = 1h 39m.

(NS component).

The 1st P.T. lasted 4m 25s and had an average period of 7,4s, there being also traces of small vibrations of an average period of 4,0s. The max. 2a was 0,07 mm.

The 2nd P.T. lasted 4m 12s. The principal average period was 10,8s, and the max. 2a was 0,14 mm.

The P.P. lasted about 7m. During the first 2m 41s, the average period was 20s, the max. 2a being 0,14 mm. The subsequent vibrations had an average period of 13,0s.

The E.P. The average period deduced from two successive groups of 50 vibrations was as follows :—

10,4s	(mean)
10,0	10,2s.

(EW component).

The 1st P.T. lasted 4m 20s. The principal average period was 7,4s, and the max. 2a was 0,03 mm.

The P.P. lasted about 22m, (Here the 2nd P.T. was not well defined.) The average period was 9,5s and the max. 2a 0,1 mm.

The E.P. The average period, measured 1h after the beginning of the earthquake, was 9,2s.

Eqke No. 218. October 14th 1899; 2h 55m 24s a.m.

Total duration = 2h 15m.

(NS component).

The 1st P.T. lasted 4m 37s. The max. 2a was 0,12 mm and the average period 7,2s.

The 2nd P.T. lasted 4m 20s. The max. 2a was 0,15 mm and the average period 9,6s. Towards the end there were traces of slow undulations.

The P.P. lasted about 7m 40s. During the first 3m 13s, the average period was about 18s (?), the max. 2a being 0,2 mm. The subsequent portion had an average period of 11,8s.

The E.P. The average period, deduced from seven successive groups of 50 vibrations, was as follows :—

9,5s	(at the commencement)	(General mean) 10.1s.
10.4		
9,9		
10,1		
10,1		
10,3		
10,5	(towards the end)	

(EW component).

The 1st P.T. lasted 4m 35s. The max. 2a was 0,1 mm and the principal average period 6,6s. Towards the end there were traces of vibrations with an average period of 11,0s.

The 2nd P.T. lasted 4m 40s. The max. 2a was 0,15 mm and the average period 8,6s.

The P.P. The motion was most active during the first 4m 20s, the max. 2a being 0,21 mm and the average period 13,0s. Thereafter the movements became regular.

The E.P. The average period, deduced from seven successive groups of 50 vibrations, was as follows :—

10,2s	(at the commencement)	(General mean) 10,1s.
10,0		
10,3		
10,5		
10,7		
9,0		
10,0	(towards the end)	

Eqke No. 219. October 17th 1899; 5h 32m 56s p.m.

The diagram showed only traces of very small movements. The following observations at the Meteorological Observatories of Matsuyama and Fukushima probably refer to the same earthquake.

Matsuyama	5h 31m 26s p.m.	Slight.
Fukushima	5, 32, 12.	,,

Eqke No. 220. October 19th 1899; 6h 28m 59s p.m.

Total duration = 2h.

This was a large earthquake at a great distance.

(EW component).

The 1st P.T. whose duration was 6m 16s consisted of vibrations of an average period of 9,4s, superposed with smaller ones of an average period of 5,2s. The max. 2a of 0,2 mm occurred at 1m 3s from the com-

mencement; this, however, not being a prominent one. The amplitude remained on the whole nearly constant.

The 2nd P.T., whose duration was 4m 15s, consisted of well defined vibrations with an average period of 9,5s, superposed with smaller ones of an average period of 6,4s. The max. 2a was 0,38 mm. There were also some irregular traces of slow undulations.

The P.P. lasted for 15m 50s and began with a slow undulation whose 2a was 0,93 mm and whose period was 38,5s. This was followed by two large vibrations of an average period of 26,3s, whose 2a was 1,75 mm, these two waves forming the most active part of the motion. For the next 14m 20s, the motion was much smaller and had an average period of 16,5s, there being also here and there traces of smaller vibrations. The 2nd max. 2a of 0,9 mm occurred at 4m 47s from the commencement.

The E.P. The average period, deduced from six successive groups of 50 vibrations, was as follows:—

10,4s	(at the commencement)	(General mean) 10,1s.
10,2		
9,4		
9,9		
10,5		
10,3	(near the end)	

(NS component).

The 1st P.T. lasted for 6m 24s. The very first displacement was 0,1 mm towards S, the counter displacement being 0,2 mm towards N. The 3rd vibration had the max. (abs.) 2a of 0,25 mm, the motion thence decreasing.—For the first 1m 28s, the average period was 8,8s. Then the motion quickened, the average period being 5,0s. From about the middle of this epoch, the average period became again slower and equal to 8,2s.

The 2nd P.T., whose duration was 4m 31s, began with the maximum 2a of 0,65 mm, thence gradually diminishing. The average period of the

principal vibrations was 8,7s, there being also traces of slower as well as quicker waves.

The P.P. began with slow undulations of an average period of 10,0s, the initial displacement being 0,5 mm. From 5m 0s after the commencement of this epoch, there appeared the proper oscillations of the pendulum, gradually swelling up to a maximum motion of 5,5 mm and then again gradually settling down. These together occupied 2m 50s, comprising 10 vibrations. For the next 15m 45s the motion consisted of well defined vibrations of an average period of 14,2s.

Eqke No. 222. October 24th 1899; 1h 3m 29s p.m.
Total duration = 2h 36m.

This was a large earthquake at a great distance.

(NS component).

The 1st P.T. whose duration was 2m 30s consisted of slow undulations of an average period of 11,5s, superposed with small vibrations of an average period of 3s. The max. 2a was 0,07 mm.

The 2nd P.T. whose duration was 3m 25s consisted of well defined vibrations of an average period of 8,5s; the max. 2a of 0,22 mm occurring at the commencement.

The P.P. lasted for about 8m 22s. For the first 2m 40s the motion had nearly the same period as in the 2nd P.T., but the amplitude was increased, the max. 2a being 0,36 mm. There were also some doubtful traces of slow undulations of an average period of about 29s. Then appeared a displacement of 0,6 mm, and the motion during the next 3m 21s remained nearly constant in amplitude, consisting of waves of an average period of 7,4s superposed on slow undulations of an average period of 16,8s. Then, for the next 6m 0s, the amplitude was large, the average period being 17,5s. For the next 2m 21s the average period was 17,6s. The motion was probably a result of the composition of the motion of the ground with the proper oscillations of the pendulum, the amplitude reaching gradually the max. 2a of 2,25 mm and then again gradually subsiding.

The E.P. The average period deduced from two successive groups of 50 vibrations, taken near the end, was as follows:—

10,2s (General mean)
10,2 10,2s.

(EW component).

The 1st P.T., whose duration was 3m 50s, consisted of undulations of an average period of 12,1s. These were superposed with smaller vibrations whose average period was, during the first 2m 3s, 3,1s and, during the remaining time interval, 6,9s. The max. 2a was 0,08 mm.

The 2nd P.T., whose duration was 3m 20s, consisted of nearly equal vibrations with an average period of 7,0s; the max. 2a of 0,16 mm occurring at the commencement.

The P.P. began with a well defined displacement of 0,36 mm. For the first 2m 14s the motion consisted of small vibrations of an average period of 6,7s, superposed more or less distinctly on slow undulations of an average period of 22s. Then followed the most active motion, which began with a 2a of 0,42 mm and had, during the first 3m 2s, an average period of 30s, the maximum 2a being 0,75 mm. There were also well defined small movements of an average period of 7,7s. For the next 2m, there were five undulations of an average period of 24s, of which the last but one had the max. (abs.) 2a of 1,7 mm. After these the motion became much smaller.

The E.P. The average period, measured towards the end, was 9,3s.

This earthquake was observed with Gray-Milne seismographs at the Meteorological Observatories of Fukushima and Mito, as follows:—

Fukushima	1h 3m 20s p.m.	Slight.
Mito	1. 3. 20 ,, ...	

Eqke No. 231. November 12th 1899; 7h 27m 13s a.m.
Total duration = 1h 10m.

This was a small earthquake at some distance. The commencement was somewhat obscure owing to the presence of very small and quick P.O.

(EW component).

The P.T. lasted for about 3m 45s.

The P.P. lasted for about 10m. For the first 3m 55s the motion consisted of slow undulations of an average period of 13s, whose (abs.) max. 2a was 0,04 mm. For the next 6m 15s the vibrations became quicker, the average period being 9,4s.

The E.P. The average period, measured near the end, was 10,6s.

(NS component).

The max. 2a was 0,04 mm.

Eqke No. 234. November 23rd 1899; 6h 52m 39s p.m.

Total duration = 4h.

The was an extremely great earthquake at a comparatively near distance, and has been recorded by the A (EW component) and B (NS component) instruments as well as by the newly erected large standard horizontal pendulum apparatus C (EW component). The duration of the P.T., measured from the diagrams of these three apparatus was as follows:—

(A) (EW)	3m 13s		
(B) (NS)	4. 8	}	(mean) 3m 32s.
(C) (EW)	3. 15		

In consequence of the great activity of motion, the pendulums of the usual two apparatus (A) and (B) were, soon after the commencement, thrown into strong proper oscillations. The apparatus C, however, has recorded the motion satisfactorily, as its period was much longer than the undulation period of the ground. I shall give therefore only the detailed description of the diagram obtained from the apparatus C.

C (EW component).

The P.T. consisted of vibrations of an average period of 7,6s, superposed in the earlier portion with smaller ones of an average period of 2.1s.

The P.P. lasted for about 1h and began with a well defined prominent slow undulation, whose period was 31s and whose displacements were as follows:—

(first motion) 2,7 mm towards W,
(counter „) 2,5 „ „ E.

This introductory motion was followed by five quicker waves of an average period of 16s, which together occupied 1m 20s. The 3rd vibration of the series, or the 4th counted from the commencement was the conspicuous (abs.) maximum, its 2a being 6,3 mm and period 16s. This group of the most active movements was followed by five vibrations of an average period of 11,2s, which together occupied 56s.—There were probably a succession of shocks at the earthquake origin, the motion consisting of a great number of alternations of large and small, as well as of slow and quick movements.

The average period. During the first 29m of the P.P. the predominating waves had an average period of 16,2s, superposed here and there with quick small vibrations of an average period of 8,2s. Then waves with shorter period predominated; slow undulations of period from 21s to 28s occurring, however, at intervals. The average period deduced from thirteen series of the successive groups of 50 vibrations, commencing at about 30m after the beginning of the P.P., was as follows:—

9,3s	
9,1	
9,4	
9,6	
8,7	
9,3	(General mean)
9,4	9,3s.
9,3	
9,0	
9,7	
9,8	
9,1	
9,5	

This earthquake was also observed with ordinary seismographs of the Gray-Milne type at the following four Meteorological Observatories :—

Nemuro	6h 51m 30s p.m.	Slight.
Fukushima	6. 54. 3	,,
Mito	6. 55. 30	,,
Tokyo	6. 53. 19	,,

Comparing the times of occurrence at these four observatories with that obtained from the horizontal pendulum diagram at the Seismological Institute, namely 6h 52m 39s, it will be seen that the ordinary seismographs have recorded the quick-period part at the commencement of the earthquake. It is to be noted that the four places of observation are all situated along or near the Pacific coast of Japan.

Eqke No. 235. November 24th 1899; 7h 2m 1s p.m.
Total duration=2h.

(EW component).

The P.T. lasted 4m 25s. The max. 2a was 0,05 mm and the average period 7,2s.

The P.P. lasted about 28m. During the first 19m the motion remained nearly constant in amplitude (max. 2a=0,55 mm), the principal average period being 14,8s. There were also vibrations of an average period of 9,3s.

The E.P. The motion consisted of regular vibrations, whose average period deduced from five successive groups of 50 vibrations was as follows :—

$$\left.\begin{array}{l} 8,9s \\ 8,5 \\ 8,6 \\ 9,6 \\ 9,2 \end{array}\right\} \begin{array}{c}\text{(General mean)} \\ 9,0s.\end{array}$$

(NS component).

The 1st P.T. lasted 5m 16s. The max. 2a was 0,05 mm and the average period 8,1s.

The 2nd P.T. lasted 4m 21s. The max. 2a was 0,9 mm and the average period 16,3s.

The P.P. lasted 19m. The motion was especially large during the first 8m 15s, which comprised two separate groups of waves of an average period of 16,5s their max. 2a being respectively 3,9 mm and 3,0 mm. In each of these groups the motion gradually swelled up to a maximum and thence again gradually decreased, owing probably to the synchronism of the pendulum oscillations with the shaking of the ground.

The E.P. The average period deduced from three successive groups of 50 vibrations, taken at 1h after the commencement of the earthquake, was as follows:—

9,7s	(General mean) 9,4s.
9,1	
9,5	

Eqkc No. 238. December 4th 1899; 9h 32m 1s a.m.

Total duration = about 40m.

This was a small earthquake at some distance.

(NS component).

The P.T. lasted for about 3¼m. But the commencemeni was doubtful. The motion seemed to consist of slow undulations.

The P.P. For the first 4m, the motion was active and consisted of vibrations of an average period of 8,5s, whose max. 2a of 0,05 mm occurred at about 2m from the commencement.

(EW component).

The P.T. lasted for 5m 40s, the motion beginning with small quick vibrations. (In this component the commencement was definite.)

The P.P. had an average period of 8,1s, the max. 2a of 0,05 mm occurring at 1¾m from the commencement.

The following observation at the Ōshima Meteorological Observatory probably refers to the same earthquake:—

Oshima (Liu Kiu) 9h 28m 36s a.m. Slight.

Eqke No. 243. December 24th 1899; 8h 52m 35s p.m.

Total duration was greater than 10m.

(NS component).

The commencement was uncertain on account of strong P.O. The larger movements lasted for 8m, the average period being 15,8s. The max. 2a was 0,15 mm.

(EW component).

The diagram was obscured by the superposition of lines.

Eqke No. 244. December 25th 1899; 6h 8m 45s a.m.

There were certain doubtful traces of small slow undulations. The diagram was, however, confused by strong P.O.

Eqke No. 245. December 28th 1899; 3h 34m 34s a.m.

Total duration = 25m.

This was a small earthquake at some distance.

The P.T. whose duration was 1m 7s consisted of very small and quick vibrations.

The P.P. lasted for about 6¼m. For the first 1m 31s the motion was comparatively small, the average period being 3,3s and the max. 2a 0,14 mm in each component. Then appeared slower and well defined waves of an average period of 5,9s, whose amplitude did not much vary during 4m 40s. The max. (abs.) 2a was 0,26 mm in each component and occurred at the middle of this epoch.

The E.P. The average period was 5,6s.

P.O. There were very slight traces of P.O., whose average period was 4,3s.

GROUP II.—*Earthquakes which originated off the eastern coast of Hokkaido (Yeso Island).*

Eqke No. 34. September 24th 1898; 9h 14m 56s a.m.

Observations at Meteorological Observatories:—

Aomori	9h 14m 10s a.m.	Slight.	
Nemuro	9. 10. 35	,,	Motion gentle.
Kushiro	9. 10. 57	,,	
Tokyo .. .	9. 16. 41	,,	
Kumagae	9. 24. 45	,,	

The motion consisted of small quick vibrations.

The P.T. lasted for about 1m 12s.

Eqke No. 42. October 7th 1898; 11h 1m 36s a.m.

Total duration = 37m.

Observations at Meteorological Observatories:—

Aomori	11h 0m 0s a.m.	Weak.	Accompanied by vertical motion.
Sapporo	11. 0. 16	Slight.	Motion gentle.
Fukushima	11. 0. 35	,,	
Tokyo	11. 0. 46	,,	
Yokohama	11. 2. 20	,,	
Kofu	11. 2. 30	,,	
Hakodate	10. 59. 51	Weak.	Pendulum clocks stopped.
Miyako	11. 0. 3	,,	Accompanied by vertical motion.
Kushiro	11. 0. 38	,,	Accompanied by sound.
Tokachi	11. 10. 42	,,	Motion gentle.
Mito	11. 1. 27	Slight.	,, ,,

(EW component).

The P.T., whose duration was 1m 22s, consisted of small quick vibrations of an average period of 1,4s, superposed on slight traces of slower waves of an average period of 9,1s. Towards the end of this epoch there appeared well defined vibrations of an average period of 4,0s.

The P.P., whose duration was 3m 30s, began with ten well defined waves of an average period of 5,4s. These were followed by larger vibrations of an average period of 5,8s; the maximum motion, which occurred at 11h 4m 0s, being 0,3 mm in the EW and 0,4 mm in the NS component.

(NS component).

The P.T., whose duration was 1m 17s, consisted of small vibrations of an average period of 1,1s, superposed on slower ones of an average period of 8s.

The P.P. During the first 45s the motion consisted of vibrations of an average period of 4,5s (?). In the following portion, the period could not be distinctly measured. From about 3¼m after the commencement of the earthquake slower waves of an average period of 9,0s became prominent.

The E.P. The average period was at first 4,3s and near the end 5,4s.

Eqke No. 136. May 8th 1899; 0h 28m 54s p.m.

Total duration = 1h 20m.

Observations at Meteorological Observatories:—

Tokachi	0h 27m 55s p.m.	Weak.	Duration long.
Hakodate	0. 28. 34	„	
Ishinomaki ..	0. 28. 48	„	Accompanied by sound; houses shaken.
Aomori	0. 29. 0	„	Houses shaken.
Yokohama ..	0. 30. 21	„	Motion gentle.
Miyako	0. 30. 59	„	Duration long.
Abashiri	0. 31. 2	„	
Nemuro	0. 25. 59	Strong.	Motion quick; pendulum clocks stopped.

Sapporo	0. 27. 58	Slight.	Motion gentle.
Kumagae	0. 28. 10	„	
Tokyo	0. 28. 32	„	Motion slow.
Fukushima ..	0. 28. 45	„	Duration long.
Mito	0. 29. 11	„	Motion quick.
Kushiro	0. 29. 39	Strong.	Motion quick; followed by minor shocks.
Yamagata ..	0. 29. 40	Slight.	
Kofu..	0. 29. 47	„	
Utsunomiya ..	0. 30. 20	„	Motion quick.
Maebashi.. .	0. 31. 31	„	
Choshi . .	0. 31. 47	„	

The P.T., whose duration was 1m 45s in the EW and 1m 41s in the NS component, consisted of well defined slow vibrations of the following average period :—

10,1s (EW component),
11,5 (NS component).

These vibrations were superposed with smaller ones of an average period of 1,2s. The max. 2a was 0,14 mm in the EW and 0,23 mm in the NS component.

The very first motion of the earthquake was 0,1 mm towards E and also 0,1 mm towards N.

The P.P. lasted 8¼m and consisted at first of quick vibrations, which here suddenly made their appearance and whose average period was 0,58s; the max. 2a being 0,25 mm in each component. These were superposed on slower waves of an average period of 8,2s, whose max. 2a of 1,3 mm in the EW and 1,1 mm in the NS component occurred at 3m 47s from the beginning of the earthquake. From about 0h 32m the motion became regular, the average period being 6,9s.

The E.P. The average period measured, in the EW component, from

eight successive groups of 50 vibrations, commencing at 0h 39m 15s, was as follows :—

8,2s
8,8
9,0
8,7 (General mean) 9,1s.
9,6
9,3
9,8
9,4

Eqke No. 142. June 5th 1899 ; 3h 46m 32s a.m.

Total duration = 25m.

Observations at Meteorological Observatories :-

Kushiro	3h 44m 30s a.m.	Weak.	Accompanied by sound.
Miyako	3. 38. 44	Slight.	
Nemuro	3. 41. 4	„	Motion gentle.
Tokachi	3. 41. 10	„	Duration short.
Mito	3. 46. 5	„	
Tokyo	3. 46. 24	„	

(NS component).

The P.T. was not sharply defined, the motion commencing very gradually. Its duration was about 2m 20s and the motion consisted of small vibrations superposed on slower ones of an average period of 9,3s.

The P.P. consisted of well defined waves of an average period of 8s, the max. 2a being 0,1 mm. At first there were also traces of small vibrations of an average period of 3,3s.

(EW component).

The max. 2a was 0,1 mm and the average period of the well defined vibrations 6,9s.

Eqke No. 160. July 11th 1899; 7h 15m 44s a.m.

Total duration = 25m.

Observations at Meteorological Observatories :—

Mito	7h 16m 32s a.m.	Slight.	
Ishinomaki .. .	7. 22. 3	„	Duration long
Kushiro .. .	7. 11. 45	Weak.	Houses shake
Tokachi . . .	7. 12. 15	„	Motion quick.
Tokyo	7. 13. 9	Slight.	
Nemuro	7. 13. 49	„	Motion gentle.
Kumagae	7. 18. 19	„	

(NS component).

The 1st P.T. lasted 54s. The motion was very small.

The 2nd P.T. lasted for 1m 5s and consisted of quick vibrations of an average period of 2,0s. The max. 2a = 0,05 mm.

The P.P., whose duration was 4m 30s, began with a well defined vibration of 0,13 mm. The max. 2a of 0,22 mm occurred 1m 21s later on. —The motion consisted of vibrations of an average period of 7,4s, superposed with quicker ones of an average period of 2,9s.

The E.P. The average period was 8,4s.

(EW component).

The 1st P.T. lasted for 1m 13s.

The 2nd P.T., whose duration was 1m 2s, consisted of quick vibrations of an average period of 5,6s. The max. 2a was 0,07 mm.

The P.P. began with three slow undulations, whose max. 2a was 0,[illegible] mm and whose average period was 22s, superposed with smaller vibrations of an average period of 4,6s. Then there followed the most active part of motion which had an average period of 6,3s; the max. 2a of 0,25 mm occurring at 2m 58s from the commencement.

P.O. The max. 2a was 0,05 mm in each component and the average period was 5,1s.

Eqke No. 161. July 11th 1899; 4h 40m 7s p.m.

Total duration = 1h 20m.

Observations at Meteorological Observatories :—

Hakodate	4h 38m 47s p.m.	Weak.	Motion gentle.
Utsunomiya	4. 23. 0 (?)	,,	
Nemuro	4. 38. 34	,,	Duration long.
Yagi	4. 39. 16	,,	
Miyako	4. 39. 27	,,	Motion gentle.
Kushiro	4. 39. 32	,,	
Akita	4. 39. 40	,,	
Kofu	4. 40. 3	Slight.	
Matsumoto	4. 40. 25	,,	
Tokyo	4. 40. 33	,,	
Fukui	4. 40. 35	,,	Duration long.
Gifu	4. 40. 48	,,	
Maebashi	4. 40. 57	,,	
Ishinomaki	4. 41. 00	,,	
Nagoya	4. 41. 1	,,	Motion gentle.
Kumagae	4. 42. 36	,,	
Mito	4. 49. 45	,,	Duration short

The P.T. lasted for 2m 23s in the EW and also 2m 23s in the NS component, the very first displacement being 0,1 mm towards E and 0,15 mm towards N. The motion consisted of very small vibrations of an average period of about 2,4s, superposed on slower ones whose average period was :—

4,4s in the EW component,
4,2 NS

There were also still slower waves, whose average period was 10,7s, and whose max. 2a was 0,2 mm in the EW and 0,3 mm in the NS component.

The P.P. lasted for 5m 40s and consisted of well defined vibrations of an average period of 9,5s, divided into max. and min. groups; the max. movements occurring as follows :—

NS component :—

2a = 2,5 mm,	occurred at	4h 42m 36s
3,3	,,	4. 43. 9
3,1	,,	4. 43. 51

EW component :—

2a = 2,7 mm,	occurred at	4h 42m 21s
2,9	,,	4. 43. 21
2,7	,,	4. 44. 9

" In the EW component these groups of waves were succeeded by a new series of comparatively regular vibrations of an average period of 6,0s, the max. (abs.) 2a of 3,3 mm occurring at its beginning. In the NS component the motion in this part of the earthquake was disturbed somewhat by the proper oscillations of the pendulum.

The E.P. The average period was at first 8,0s and towards the end 9,6s.

Eqke No. 164. July 17th 1899; 11h 21m 0s a.m.

Total duration = 1h 37m.

Observations at Meteorological Observatories :—

Nemuro .. .. 11h 18m 12s a.m. Slight.

(EW component).

The P.T., whose duration was 2m 10s, consisted of small vibrations of an average period of 5,0s.

The P.P. commenced with well defined waves of an average period of 13s, whose max. 2a of 0,2 mm occurred at the beginning.

The E.P. The average period deduced from two groups of 50 vibrations was as follows :—

10,9s (at the commencement)	}	(General mean)
10,1 (towards the end)	}	10,5s.

(NS component).

The P.T. lasted for 2m 49s.

The P.P. For the first 2m 48s, the motion consisted of slow undulations (max. 2a = 0,04 mm) of an average period of 16,1s. The motion then became quicker, the average period being 9,5s. The max. (abs.) 2a of 0,08 mm occurred at 6m 30s from the commencement of the earthquake.

Eqke No. 181. August 10th 1899; 4h 59m 51s a.m.

Total duration = 13m.

Observations at Meteorological Observatories:—

Tokachi	.. .. ..	5h 2m 40s a.m.	Rather weak.	Motion quick.
Nemuro	.. .. ..	5. 0. 31	Slight.	Motion gentle.

(NS component).

The commencement was not well defined, but the P.T. lasted for about 1m 38s (?).

The P.P. lasted for 3m 35s. During the first 30s the motion consisted of small quick vibrations (max. 2a = 0,05 mm) of an average period of 2,7s. During the next 3m 5s the motion was larger and had an average period of 6,2s, the amplitude remaining nearly constant. Max. 2a was 0,1 mm.

The E.P. The average period was 4,1s.

The EW component diagram was not satisfactorily taken, owing to certain unknown causes.

Eqke No. 228. November 10th 1899; 8h 58m 25s p.m.

Total duration = 1h.

Observations at Meteorological Observatories:—

Nemuro	.. ..	8h 56m 10s p.m.	Weak.	Accompanied by sound; houses shaken.
Tokachi	.. ..	8. 56. 58	,,	Duration short.
Kushiro	.. ..	8. 57. 18	,,	Houses shaken.

Ishinomaki ..	8. 58. 59 p.m.	Weak.	
Miyako .. .	9. 1. 29	"	Accompanied by vertical motion.
Hakodate . ..	8. 57. 55	Slight.	Slight.
Mito	8. 59. 0	"	
Tokyo . ..	8. 59. 2	"	
Fukushima	8. 59. 22	"	
Choshi	8. 59. 58	"	
Akita	9. 0. 1	"	
Kumagae . .	9. 0. 6	"	
Yokohama . .	9. 0. 40	"	
Abashiri ..	9. 1. 20	"	Motion gentle.
Kochi	9. 4. 1	"	
Aomori . .	9. 8. 0	"	
Maebashi . .	9. 20. 1 (?)	"	

(EW component).

The P.T., whose duration was 1m 22s, consisted of very small vibrations of an average period of 3,9s.

The P.P. lasted for 6m 15s. For the first 2m 10s the motion consisted essentially of waves (max. 2a=0,12 mm) of an average period of 6,5s, superposed with very quick small vibrations which made their appearance first at the commencement of this epoch. The succeeding waves were well defined and most active for 3m 30s, their average period being 5,7s. The max. 2a was 0,25 mm.

The E.P. The average period, deduced from two successive groups of 60 vibrations, taken at 30m after the commencement of the earthquake, was as follows :—

8,6s	(General mean)
8,7	8,7s.

(NS component).

The P.T., whose duration was 1m 34s, consisted of small vibrations of an average period of 3,9s.

The P.P. began with small quick vibrations, whose max. 2a was 0,05 mm in each component and whose traces were continued for about 1m 55s. These were superposed on slower waves, whose max. 2a was 0.12 mm and whose average period was 8,2s. The succeeding vibrations were quicker and better pronounced, their average period being 5,3s and the max. 2a 0,2 mm.

The E.P. The average period, measured at about 30m after the commencement of the earthquake, was 9,1s.

Eqk No. 232. November 18th 1899; 4h 23m 8s p.m.

Total duration = 33m.

Observations at Meteorological Observatories :—

Hakodate	4h 21m 47s p.m.	Weak.	
Nemuro	4. 1. 24*	Slight.	Motion gentle.
Kushiro	4. 3. 23*	,,	Accompanied by vertical motion.
Fukushima ..	4. 3. 59*	,,	
Ishinomaki .	4. 21. 4	,,	
Fukushima ..	4. 21. 45	,,	
Miyako	4. 22. 5	,,	
Tokyo	4. 23. 14	,,	
Akita	4. 24. 30	,,	
Mito	4. 25. 58	,,	

(EW component).

The P.T. lasted for 2m 0s. Towards the end, the average period was 9,5s.

The P.P. During the first 1m 21s the motion consisted of small quick vibrations (max. 2a = 0,05 mm) of an average period of 2,7s, superposed on traces of slow undulations of an average period of 16,2s. Then there appeared well defined vibrations of an average period of 5.2s. The max. 2a was 0,13 mm.

* These observations may refer to another earthquake.

The E.P. The average period, measured towards the end, was 5,9s. (NS component).

The P.T. lasted for 2m 0s.

The P.P. During the first 1m 3s the motion was small (max. 2a = 0,05 mm), and consisted of quick vibrations of an average period of 3,3s, superposed on traces of slower undulations of an average period of 21s. (So far may probably be taken as the 2nd P.T.). Then appeared well defined vibrations of an average period of 5,0s, superposed on traces of slower ones of an average period of 9,6s. The max. 2a was 0,14 mm.

GROUP III.—*Earthquakes which originated off the north-eastern coast of Honshiu (Main Island).*

Eqke No. 4. **July 20th 1898; 6h 46m 14s p.m.**

Total duration = about 14m.

Observations at Meteorological Observatories.

Ishinomaki	6h 38m 33s p.m.	Weak.	Houses shaken
Fukushima . .	6. 37. 32	Slight.	Motion quick.
Akita	6. 39. 55	,,	
Miyako	6. 41. 6	,,	
Yamagata	6. 41. 10	,,	
Tokyo	6. 41. 54	,,	
Kofu	6. 42. 2	,,	Duration long.
Mito	6. 42. 53	,,	

(**EW component**).

The P.T., whose duration was 31s, consisted of very small vibrations.

(**NS component**).

The P.P. began with small vibrations of an average period of 3,2s, whose max. 2a was 0,09 mm in the EW and 0,05 mm in the NS component; with a series of still quicker and smaller waves superposed. At about 1m 50s from the commencement of the earthquake, there appeared slower vibrations, whose average period was 7,7s and whose max. 2a was 0,1 mm in each component. On these were superposed smaller waves of an average period of 2,5s.

The E.P. The motion consisted of vibrations with an average period of 3,2s, superposed on others with an average period of 5,4s.

Eqke No. 16. **August 21st 1898; 0h 8m 22s a.m.**

Total duration = about 45m.

Observations at Meteorological Observatories :—

Ishinomaki	0h 5m 0s a.m.	Slight.	Only recorded by instrument.
Miyako	0. 7. 35	,,	Motion quick ; followed by after shocks.
Aomori	0. 8. 15	,,	Only recorded by instrument.
Nemuro	0. 9. 36	,,	Motion gentle.
Tokyo	0. 9. 39	..	

(NS component).

The 1st P.T., whose duration was 56s, consisted of very small vibrations of an average period of 1,1s, superposed on traces of slower waves of an average period of 8,0s. The beginning was well defined.

The 2nd P.T., whose duration was 1m 24s, consisted of well defined undulations of an average period of 10,5s, the max. 2a being 0,14 mm in the NS and 0,16 mm in the EW component. The superposed small vibrations were also larger than in the 1st P.T.

The P.P. commenced with slow undulations of an average period of 15,0s, whose max. 2a was 0,4 mm in the NS and 0,2 mm in the EW component; quicker waves with an average period of 7,7s being superposed. At about 4m 48s from the commencement of the earthquake the waves became simpler and regular, the average period being 7,5s.

The E.P. The average period deduced from two successive groups of 50 vibrations was as follows :—

7,8s (General mean)
7,9 7,9s.

Eqke No. 17. August 21st 1898 ; 1h 28m 44s a.m.

Total duration = 15m.

Observations at Meteorological Observatories :—

Aomori	1h 29m 10s a.m.	Slight.	Only registered by instrument.
Kumagae	1. 29. 29	„	
Miyako	1. 29. 32	„	
Tokyo	1. 29. 51	„	

(NS component).

The P.T., whose duration was 54s, consisted of very small vibrations of an average period of 1,4s. The beginning as well as the end of this epoch was quite well marked.

The P.P. began with quick vibrations (max. 2a=0,02 mm), superposed on slow undulations (max. 2a=0,05 mm) of an average period of 17,2s. During the earlier part there were present quick small waves which were evidently of the same nature as those occurring in the P.T. From about 1h 29m 42s there predominated waves of an average period of 3,9s, superposed with small vibrations of an average period of 1,1s. From about 1h 31m 42s, the average period of the predominating waves was reduced to 6,9s.

The EW component diagram was obscured by the superposition of several lines.

Eqke No. 19. August 23rd 1898; about 8h 5m 17s a.m.

Total duration=5m.

Observations at Meteorological Observatories:—

Ishinomaki	8h 2m 30s a.m.	Slight.	
Kofu	8. 4. 15	„	Motion quick.
Miyako	8. 4. 19	„	
Mito	8. 4. 42	„	Accompanied by vertical movements.
Kumagae	8. 5. 9	„	

The P.T. lasted for about 56s and consisted of very small vibrations of an average period of 1,1s, superposed on others of an average period of 3,3s.

The P.P. consisted of comparatively regular vibrations of an average period of 4.6s. The max. 2a of 0,04 mm in each component occurred at 28s from the commencement of this epoch.

The E.P. The average period was about 4,2s.

Eqke No. 30. September 15th 1898; 7h 18m 37s p.m.

Total duration = $8\frac{1}{2}$m.

Observations at Meteorological Observatories:—

Miyako	6h 58m 5s p.m.	Slight.
Yamagata	7. 0. 0	,,
Aomori	7. 0. 0	,,
Hakodate	7. 0. 0	,,
Fukushima	7. 0. 35	,,
Kumagae	7. 1. 25	,,
Mito	7. 19. 30	,,

The P.T. lasted for about ? s.

The principal vibrations had an average period of 4,3s, these being superposed with others still smaller.

Eqke No. 31. September 16th 1898; 4h 48m 32s a.m.

Total duration = 17m.

Observations at Meteorological Observatories:—

Mito	4h 48m 25s a.m.	Weak.	Motion quick; accompained by vertical motion.
Maebashi	4. 48. 29	,,	Motion gentle.
Kumagae	4. 48. 40	,,	Duration long.
Choshi	4. 47. 0	Slight.	
Yamagata	4. 47. 10	,,	
Fukushima ..	4. 47. 24	,,	Motion gentle.
Ishinomaki ..	4. 47. 30	,,	
Yokohama ..	4. 48. 18	,,	Motion gentle.
Tokyo	4. 48. 23	,,	

Yokosuka	4h 48m 58s a.m.	Slight.
Kofu	4. 50. 00 (?)	,,
Matsumoto ..	4. 36. 00 (?)	,,
Utsunomiya ..	4. 49. 20	,,

The P.T. lasted for about 27s.

The P.P. The max. 2a was 0,4 mm in the EW and 0,5 mm in the NS component. The motion consisted of quick vibrations, superposed more or less definitely on traces of slower ones of an average period of 5,3s.

The E.P. The average period deduced from three successive series of 40 vibrations, counted from 3½m after the beginning of the earthquake, was as follows:—

$$\left.\begin{matrix}3{,}5\text{s}\\3{,}9\\5{,}5\end{matrix}\right\}\begin{matrix}\text{(General mean)}\\4{,}3\text{s.}\end{matrix}$$

Eqke No. 36. September 26th 1898; 10h 27m 44s a.m.
Total duration = about 12m.

Observations at Meteorological Observatories:—

Fukushima	10h 25m 20s a.m.	Slight.	Motion quick.
Ishinomaki	10. 25. 30	,,	
Utsunomiya	10. 28. 0	,,	
Tokyo	10. 28. 43	,,	
Kofu	10. 30. 20	,,	
Kumagae	10. 37. 22	,,	

(EW component).

The P.T. lasted for 32s.

The P.P. The motion consisted at first of small vibrations of an average period of 2,6s, superposed on others of an average period of 5,9s. The max. 2a was 0,05 mm.

The E.P. Near the end the average period was 3,9s.

NS component).

The P.T. lasted for 32s.

The P.P. The max. 2a was about 0,05 mm.

Eqke No. 53. November 8th 1898; 2h 56m 47s a.m.
Total duration = 18m.

Observations at Meteorological Observatories:—

Fukushima ..	2h 57m 30s a.m.	Weak.	Houses shaken.
Mito	2. 58. 30	,,	Motion quick; houses shaken.
Tokyo	2. 59. 5	,,	
Choshi	2. 56. 36	Slight.	
Fukui	2. 58. 47	,,	
Maebashi	2. 58. 58	,,	Motion quick.
Kumagae	2. 59. 0	,,	,,
Utsunomiya ..	3. 0. 0	Weak.	Motion gentle.
Yokohama	3. 1. 30	Slight.	,,
Miyako	3. 0. 49	,,	

The P.T., whose duration was 19s, consisted of small vibrations of an average period of about 1,4s, superposed with still quicker ones.

The P.P., whose duration was 3m 50s, consisted of vibrations of an average period of 3,1s, whose max. 2a was 0,8 mm in the EW and 1,4 mm in NS component; still quicker ones of an average period of about 0,8s being superposed. From about 2h 57m 33s waves of an average period of 9,3s became prominent, superposed with some small vibrations. 30s later on the waves became well defined and free from superpositions and had an average period of 3,8s; their maximum of 0,7 mm in the EW and 0,45 mm in the NS component occurring at 3h 0m 17s.

P.O. There were very small but distinct traces of P.O. Their average period, deduced from two successive groups of vibrations immediately after the earthquake, was as follows:—

4,2s (meaned from 70 vibrations),
4,2 („ „ 200 „).

Eqke No. 68. December 7th, 1898; 9h 12m 50s a.m.
Total duration = 10m.

Observations at Meteorological Observatories:—

Fukushima	.. ..	9h 13m 2s a.m.	Slight.

The P.T., whose duration was about 44s, consisted of very quick small vibrations.

The P.P. consisted of vibrations of an average period of 7,2s, superposed with smaller waves. The max. 2a was 0,08 mm in the EW and 0,06 mm in the NS component.

P.O. The max. 2a was 0,05 mm in each component, and the average period, measured 2 hours before the earthquake, was 6,7s.

Eqke No. 70. December 13th 1898; 1h 34m 48s a.m.
Total duration = about 19m.

Observations at Meteorological Observatories:—

Hakodate	1h 33m 27s a.m.	Slight.	Motion gentle.
Aomori	1. 35. 0	„	Motion quick.
Tokyo	1. 35. 38	„	

(EW component).

The 1st P.T., whose duration was 81s, consisted of extremely slight traces of waves of an average period of 6,8s, superposed with very small vibrations.

The 2nd P.T., whose duration was 42s, had an average period of about 2,5s (?); the max. 2a being 0,08 mm.

The P.P., whose duration was 5½m, began with well pronounced vibrations of an average period of 3,7s, whose max. 2a was 0,25 mm. After 2m 15s there appeared another group of waves, which commenced with a max. 2a of 0,35 mm and had an average period of 7,0s.

The E.P. The average period was about 5,8s.
(NS component).

The P.P. In the earlier portion the motion consisted of vibrations of an average period of 8,5s, superposed with smaller ones of an average period of 3,2s. The max. 2a was 0,3 mm.

P.O. There were slight traces of P.O., whose average period was 3,9s.

Eqke No. 71. December 14th 1898; 3h 27m 15s p.m.
Total duration = 1m 10s.

Observations at Meteorological Observatories: —

Ishinomaki . . .	3h 19m 42s p.m.	Slight.
Mito . .	3. 25. 58	„
Tokyo . .	3. 26. 9	„
Utsunomiya . . .	3. 27. 0	„
Fukushima	3. 27. 0	„
Maebashi	3. 27. 9	„

The diagram was obscured by very powerful P.O., whose max. 2a was 0,15 mm in each component, and whose average period was 5,4s.

The earthquake motion consisted of small quick vibrations, whose max. 2a was 0,09 mm in the EW and 0,04 mm in the NS component.

Eqke No. 85. February 1st 1899; 1h 34m 55s a.m.
Total duration = 54m.

Observations at Meteorological Observatories:—

Matsumoto .	1h 35m 4s a.m.	Slight.	
Aomori	1. 36. 30	„	Motion gentle.
Yamagata	1. 37. 0	„	
Miyako	1. 37. 2	„	
Mito	1. 37. 8	„	
Tokyo	1. 37. 42	„	
Fukushima	1. 37. 51	„	Motion gentle.
Kumagae	1. 37. 54	„	
Yokohama	1, 39, 52	„	

(EW component).

The P.T., whose duration was 1m 5s, consisted of small vibrations of an average period of 2,5s, superposed on slower waves of an average period of 7,0s. The small superpositions were present also during the first 7m 15s of the P.P.

The P.P. which lasted for 10m 30s, began with two slow undulations of an average period of 20,5s, whose max. 2a was 1,0 mm. During the next 2m 12s, the motion consisted essentially of vibrations (max. 2a = 0,75 mm) of an average period of 11,0s. Again during the next 1m 11s the predominating waves were quicker and had an average period of 5s. These were followed by vibrations of an average period of 9,0s, superposed more or less definitely on slower ones of an average period of 13,3s. The absolute max. 2a of 0,75 mm (period 9,1s) occurred at 6m 0s from the beginning of the earthquake and formed the very last vibration of the most active portion.

The E.P. The average period deduced from two successive groups of 50 vibrations was as follows :--

8,8s	(General mean)
9,6	9,2s.

(NS component).

The P.T. lasted for 1m 4s.

The P.P. The max. 2a was 0,7 mm.

Eqke No. 89. February 13th 1899; 4h 29m 49s a.m.

This was a very small earthquake.

Observations at Meteorological Observatories :—

Ishinomaki	5h 11m 50s a.m.	Weak.	
Tokyo	5. 15. 7	Slight.	
Fukushima	5. 16. 0	„	Houses shaken.
Miyako	5. 20, 14	„	Motion quick,

Eqke No. 90. February 20th 1899; 7h 37m 58s a.m.

Total duration = about 5m.

Observations at Meteorological Observatories:—

Tokyo	4h 47m 1s a.m.	Slight.	
Yamagata .. .	7. 47. 40	,,	
Kumagae .. .	7. 47. 8	,,	
Mito	7. 47. 50	Weak.	Motion quick.
Utsunomiya	7. 48. 28	Slight.	Motion gentle.
Fukushima .. .	7. 49. 5	,,	Houses shaken.
Ishinomaki	7. 49. 23	,,	

The 1st P.T. lasted for 27,7s and consisted of very small quick vibrations.

The 2nd P.T., whose duration was 4s, also consisted of small vibrations.

The P.P., whose duration was 26s, consisted of small vibrations; the max. 2a of 0,08 mm in the EW and 0,06 mm in the NS component occurring at the commencement of this epoch.

P.O. There were slight traces of P.O. whose average period was 5,8s.

Eqke No. 94. February 28th 1899; 11h 15m 40s p.m.

Total duration = about 5m.

Observations at Meteorological Observatories:—

Kofu	11h 15m 55s p.m.	Slight.
Tokyo	11. 16. 6	,,
Mito	11. 16. 45	,,
Maebashi	11. 17. 41	,,

The P.T., whose duration was 53s, consisted of small quick vibrations superposed on traces of slow undulations.

The P.P., whose duration was 13s, began with a well defined motion of 0,1 mm towards E and 0,05 mm towards S. In the EW component the max. 2a of 0,12 mm occurred at 5s from the beginning of the P.P.; while

in the NS component the max. 2a of 0,1 mm occurred at 2,2s and also at 5s after the same moment.

Eqke No. 103. March 16th 1899; 4h 49m 14s a.m.
Total duration = 27m.

Observations at Meteorological Observatories:—

Yokohama ..	4h 28m 0s	.. Slight.	
Tokyo	4. 50. 27	..	
Mito..	4. 50. 53	..	Motion gentle.
Kofu	4. 52. 15		
Utsunomiya ..	4. 52. 20		
Miyako	4. 54. 34		
Nagano	4. 51. 29		
Fukushima	4. 53. 23		

The P.T., whose duration was 1m 36s, consisted of very small vibrations of an average period of 2,4s.

The P.P., whose duration was 7m, consisted of slow waves of an average period of 8,7s, superposed with quicker vibrations. The max. 2a's of 0,28 mm in the EW and of 0,24 mm in the NS component occurred respectively at 3m 45s and 4m 36s from the commencement of the earthquake. In the later part of this epoch the motion consisted of vibrations of an average period of 6,4s, superposed here and there with small movements of an average period of 3,3s.

The E.P. The average period was 7,0s.

Eqke No. 105. March 20th 1899; 3h 25m 47s a.m.
Total duration = 21m.

Observations at Meteorological Observatories:—

Miyako	3h 24m 43s a.m.	Slight.
Hakodate..	3. 25. 57	"

(EW component).

The 1st P.T., whose duration was 64s, consisted of very small vibrations of an average period of 2,1s.

The 2nd P.T. lasted for 77s. The amplitude remained nearly constant throughout this epoch, the max. 2a being 0,05 mm in each component. Near the commencement the average period was 2,4s, while towards the end it was 4,9s.

The P.P., whose duration was 4m 40s, began with 7 vibrations which together occupied 36,8s and had an average period of 5,3s. Then followed the most active group of 8 waves, whose max. 2a was 0,15 mm and whose average period was 4s. The succeeding waves had an average period of 5,0s.

The E.P. was somewhat obscured by small P.O., whose average period, measured immediately before the earthquake was 3,5s.
(NS component).

The max. 2a was 0,06 mm.

Eqke No. 106. March 20th 1899; 4h 12m 29s p.m.
Total duration=16m.

Observations at Meteorological Observatories:—

Ishinomaki	4h 7m 57s p.m.	Slight.	
Miyako	4. 12. 36		
Hakodate	4. 13. 20		
Mito	4. 14. 20	,,	Motion gentle.

The P.T., whose duration was about 32s, consisted of very small vibrations.

The P.P. lasted about 4½m. At about 1m 29s from the commencement of the earthquake, there appeared the most active group of waves, which together occupied 1m 52s and had an average period of 3,8s. The max. 2a was 0,15 mm in the EW and 0,12 mm in the NS component.

Eqke No. 108. March 22nd 1899; 7h 22m 36s p.m.
Total duration=23m.

Observations at Meteorological Observatories :—

Ishinomaki .. .	7h 22m 17s p.m.	Weak.	Houses shaken.
Fukushima	7. 23. 50	,,	Followed by after-shocks.
Maebashi .. .	7. 21. 59	Slight.	Motion gentle.
Yamagata .. .	7. 22. 0	,,	
Mito	7. 22. 45	,,	Motion quick.
Miyako	7. 22. 56	,,	
Tokyo	7. 23. 0	,,	Motion slow.
Nagano	7. 23. 6	,,	
Kumagae .. .	7. 23. 29	,,	
Utsunomiya.. ..	7. 23. 38	,,	Motion slow.
Matsumoto	7. 23. 47	,,	
Hikone	7. 23. 50	,,	Motion gentle.
Yokohama	7. 23. 53	,,	
Kofu	7. 24. 16	,,	

The P.T., whose duration was 34s, consisted of very small vibrations.

The P.P. lasted about 4½m. During the first 2m, the motion was superposed with small movements of an average period of about 1,8s; there being in the earlier part some traces of still quicker vibrations. The max. 2a of the vibrations, which occurred at the commencement of the P.P., was 0,45 mm in the EW and 0,3 mm in the NS component. From about 7h 23m 24s there appeared 19 large well defined vibrations of an average period of 6,7s, their max. 2a which occurred at 7h 24m 20s being 0,52 mm in the EW and 0,3 mm in the NS component. These were followed by waves of an average period of 3s.

The E.P. The principal average period, deduced from two successive groups of 50 vibrations, in the EW component, was as follows :—

$$\left.\begin{matrix} 7{,}1s \\ 8{,}0 \end{matrix}\right\} \quad \begin{matrix} \text{(General mean)} \\ 7{,}6s. \end{matrix}$$

Eqke No. 120. April 9th 1899; 5h 42m 22s a.m.

Total duration = 18m.

Observations at Meteorological Observatories:—

Miyako	5h 40m 0s a.m.	Slight.
Fukushima	5. 41. 5	,,
Mito	5. 42. 52	,,
Yokohama	5. 42. 59	..
Ishinomaki ..	5. 43. 11	,,
Utsunomiya ..	5. 43. 34	,,
Tokyo	5. 42. 58	,,

(EW component).

The P.T., whose duration was about 30s (?), consisted of very small vibrations.

The P.P., whose duration was 12m, began gradually. For the first 1m 30s, the motion consisted of small vibrations of an average period of 3,3s (mixed with still smaller ones), superposed on slower waves of an average period of 9,0s. Then followed, for 1m 30s, thirteen well defined vibrations of an average period of 6,9s, whose max. (abs.) 2a of 0,1 mm occurred at 2¼m after the commencement of the earthquake. The motion then showed a series of alternations of maximum and minimum groups, the average period being 9,0s.

The E.P. was confused by slight P.O.

P.O. The average period, measured before the earthquake, was 3,7s.

(NS component).

The sharp conical point of the horizontal strut of the pendulum had been broken and accordingly the natural period of oscillation of the latter was reduced to about 6s. Consequently the diagram was not satisfactory, the pendulum having been, during the earthquake, thrown into its own motion.

Eqke No. 122. April 13th 1899; 4h 29m 57s a.m.

Total duration=2m 30s.

Observations at Meteorological Observatories:—

Yokohama..	4h 25m 11s a.m.	Slight.	Motion quick.
Ishinomaki	4. 26. 11	,,	

Utsunomiya .	4h 29m 30s a.m.	Slight.	Motion quick.
Maebashi	4. 30. 8	,,	,,
Tokyo	4. 30. 44	,,	
Mito	4. 30. 55	,,	Motion quick.
Miyako	4. 32. 28	,,	
Choshi	4. 33. 8	,,	
Fukushima	4. 37. 15	,,	Motion quick.

The commencement was confused by small P.O. The duration of the P.T. was approximately 14s.

The P.P. consisted of quick vibrations, the max. 2a being 0,12 mm in the EW and 0,05 mm in the NS component.

Eqke No. 125. April 16th 1899; 2h 27m 28s p.m.
Total duration = 17m.

Observations at Meteorological Observatories:—

Utsunomiya . .	2h 27m 20s p.m.	Slight.	Motion quick.
Fukushima .	2. 27. 27	,,	Houses shaken.
Yamagata	2. 27. 56	,,	
Choshi	2. 28. 0	,,	
Kofu	2. 28. 10	,,	
Mito	2. 28. 16	,,	Motion quick.
Yokohama .	2. 28. 20	,,	Motion gentle.
Ishinomaki . .	2. 28. 34	,,	
Miyako	2. 29. 18	,,	Motion gentle.
Tokyo	2. 28. 14	,,	

(NS component).

The P.T., whose duration was 23s, consisted of small quick vibrations.

The P.P. lasted for 4m 40s and consisted for the first 47s of quick vibrations, whose max. 2a of 0,1 mm occurred near the commencement. After this, the motion consisted of vibrations of an average period of 1,7s superposed on slower ones of an average period of 3,3s. These latter

became prominent first from 1m 46s after the beginning of the earthquake: their max. 2a was 0,1 mm.

(EW component).

The P.T. lasted for 23s.

The P.P. consisted at first of quick vibrations superposed on waves of an average period of 2,6s, whose max. 2a of 0,2 mm occurred at 38s. from the beginning of the earthquake.

The E.P. The average period was 3,5s.

Eqke No. 128. April 19th 1899; 3h 13m 6s (?) p.m.

Total duration = 2m 20s.

Observations at Meteorological Observatories :—

Fukushima	3h 33m 40s p.m.	Slight.	
Utsunomiya ..	3. 34. 5	,,	Motion quick.
Mito	3. 34. 30	,,	,,
Choshi	3. 34. 45	,,	
Tokyo	3. 34. 49	,,	
Yokohama	3. 34. 56	,,	
Matsumoto	3. 36. 32	,,	

The beginning was confused by P.O. The P.T. lasted, however, for about 9s.

The P.P. The motion consisted of quick vibrations, the max. 2a being 0,04 mm in the EW and 0,02 mm in the NS component.

The E.P. In the EW component, there existed traces of vibrations of an average period of 1,6s.

Eqke No. 148. June 15th 1899; 3h 49m 41s p.m.

Total duration = 25m.

Observations at Meteorological Observatories :—

Aomori	3h 49m 0s p.m.	Weak.	
Ishinomaki	3. 48. 39	Slight.	Motion gentle.

Miyako	3h 48m 51s p.m.	Slight.
Akita	3. 49. 30	,,
Mito	3. 49. 42	,,
Fukushima	3. 50. 18	,,
Tokyo	3. 50. 59	,,

(EW component).

The P.T. lasted for 1m 18s. Towards the end the motion consisted of well defined vibrations of an average period of 3,0s, superposed with still smaller ones.

The P.P. lasted for about 8m. During the first 1m 46s the motion was small (max. 2a=0,15 mm) and consisted of vibrations of an average period of 2,7s, superposed more or less definitely on traces of slower ones. Then took place the max. (abs.) 2a of 0,25 mm, followed by 13 well defined vibrations, which gave an average period of 7,3s. Towards the end waves of an average period of 3,6s were prominent.

The E.P. Towards the very end, the average period was 9,2s.

(NS component).

The max. 2a was 0,2 mm.

Eqke No. 150. June 17th 1899; 10h 9m 35s a.m.

Total duration=1h 19m.

Observations at Meteorological Observatories :—

Ishinomaki	9h 41m 15s a.m.	Slight.	
Fukushima	10. 8. 58	,,	
Nemuro	10. 9. 30	,,	
Mito	10. 10. 0	,,	
Miyako	10. 10. 49	,,	Motion quick.
Aomori	10. 11. 0	,,	
Mito	10. 12. 15	,,	
Tokyo	10. 12. 45	,,	

(NS component).

The P.T., whose duration was 2m 32s, consisted of waves of an

average period of 7,2s, superposed with vibrations of an average period of 2,9s and also with other still smaller ones. The max. 2a of 0,0[illegible] mm occurred at 8s from the commencement.

The P.P., whose duration was 7m, was especially active during the first 3m. It began with a well demarked 2a of 0,12 mm and became large at the 3rd vibration whose 2a was 0,4 mm. The max. 2a of 0,58 mm occurred at 10h 10m 38s. The waves had an average period of 8,9s, superposed with others of an average period of 5,5s.

The E.P. The average period was 7,4s.

(EW component).

The P.T. lasted for 2m 32s.

The P.P. The motion began with a displacement of 0,22 mm and became large at the 3rd vibration whose 2a was 0,45 mm. During the next 2m 33s the motion remained on the whole nearly constant, the max. 2a of 0,58 mm occurring at 10h 12m 12s.

Eqke No. 151. June 18th 1899; 1h 52m 27s p.m.

Total duration = 24m.

Observations at Meteorological Observatories:—

Fukushima	1h 53m 30s p.m.	Slight.
Miyako	1. 54. 53	
Tokyo . . .	1. 54. 55	

(NS component).

The P.T. lasted for about 1m 43s and consisted of extremely small vibrations.

The P.P., whose duration was 4m 10s, began with a displacement of 0,1 mm. For the first 1m 2s the motion remained small and consisted of vibrations of an average period of 3,7s, superposed with other still smaller ones. Then there followed 5 well defined slower vibrations of an average period of [illegible],7s, the last having the max. (abs.) 2a of 0,11 mm.

The E.P. Towards the very end, the average period was 6,9s.

(EW component).

The P.P. began with a displacement of 0,1 mm. During the first 1m 55s the motion was small and consisted of small vibrations of an average period of 2,4s, superposed on others of an average period of 4,7s. Then there followed the most active part of the motion, which lasted for 5m and whose max. 2a of 0,13 mm occurred at 2m 6s from the commencement.

Eqk No 165. July 18th 1899; 1h 59m 0s a.m.

Total duration=20m.

Observations at Meteorological Observatories:—

Kumagae	1h	7m	48s a.m.	Slight.	
Fukui	1.	58.	16	„	
Fukushima	1.	58.	10	„	
Choshi	1.	58.	25	„	
	1.	58.	41	„	
Nagoya	1.	59.	5	„	
Tokyo	1.	59.	7	„	
Mito	1.	59.	40	„	Motion quick.
Yokohama	2.	0.	45	„	
Utsunomiya	2.	1.	20	„	Motion gentle.
Tokyo	2.	1.	48	„	

(EW component).

The P.T., whose duration was 11,6s, began with a displacement of 0,04 mm towards E and 0,05 mm towards S.

The P.P. began with a displacement of 0,1 mm in the EW and 0,05 mm in the NS component. For the first 33s the motion remained sensibly constant and consisted of vibrations of an average period of 2,1s, superposed with small quick ones. Then there followed, for 1m 8s, well defined slower vibrations of an average period of 8,5s, whose amplitude remained sensibly constant; the max. 2a was 0,15 mm in the EW and 0,09 mm in the NS component.—The superposed small vibrations ceased almost completely at 1m 12s from the commencement of the earthquake. 32s later

on, however, these vibrations (max. 2a=0,15 mm) again appeared, the motion remaining small for about 6s, when the max. (abs.) 2a above noted took place. Perhaps there was a second shock the motion consisting, during the next 1m 25s, of small vibrations superposed more or less distinctly on slower ones of an average period of 5,0s. Then there followed vibrations of an average period of 7,5s, superposed with others of an average period of 3,8s; the max. 2a during this part of motion being 0,15 mm in the EW and 0,14 mm in the NS component.

The E.P. The principal average period was 7,1s.

Eqke No. 176. August 3rd 1899; 6h 52m 57s p.m.

Total duration=20m.

Observations at Meteorological Observatories:—

Mito	6h 51m 31s p.m.	Rather strong.	Houses shaken.
Ishinomaki	6. 54. 28	„	„
Maebashi	6. 51. 6	Weak.	Motion gentle.
Fukushima	6. 51. 17	Rather weak.	Houses shaken.
Miyako	6. 51. 18	„	Duration long.
Yokohama	6. 52. 13	„	Motion quick.
Akita	6. 58. 0	„	Doors shaken.
Yamagata ...	6. 51. 10	Slight.	
Utsunomiya ...	6. 51. 20	„	Motion gentle.
Tokyo	6. 51. 54	„	„
Kumagae	6. 52. 2	„	„
Nemuro	6. 52. 17	„	„
Iida	6. 53. 51	„	Duration short.

The P.T., whose duration was 33s, consisted of small quick vibrations. In the NS component the amplitude remained nearly constant. But in the EW component there was a prominent max. 2a of 0,07 mm at 10s from the beginning, and a second max. 2a of 0,06 mm 8s later on.

The P.P. began with a displacement of 0,2 mm towards E and 0,1 mm towards S, followed by the counter movement (max.) of 0,4 mm towards W and 0,45 mm towards N. During the first 1m 20s, quick

vibrations were superposed on slower ones of an average period of 3,2s. For the next 1m 50s, the predominating average period was 6,9s, the max. 2a during this part of motion being 0,3 mm in the EW and 0,33 mm in the NS component. Then followed quicker waves of an average period of 3,2s.

The E.P. The motion consisted of vibrations of an average period of 3,8s superposed more or less distinctly on slower ones of an average period of 8,2s.

Eqke No. 182. August 13th 1899; 2h 26m 17s p.m.

Total duration = 7m.

Observations at Meteorological Observatories:—

Kumagae	2h 25m 18s p.m.	Slight.
Mito	2. 25. 45	,,
Ishinomaki .. .	2. 26. 30	,,
Tokyo	2. 26. 41	,,
Maebashi	2. 27. 2	,,
Yokohama ..	2. 27. 18	,,
Fukushima	2. 28. 8	,,
Miyako	2. 28. 6	,,
Akita..	2. 29. 46	,,

The P.T. lasted for 15s.

The P.P. consisted of small quick vibrations. The max. 2a was 0,06 mm in the EW and 0,05 mm in the NS component.

The E.P. The average period was about 3s.

Eqke No. 184. August 14th 1898; 8h 48m 24s a.m.

Total duration = 7m.

Observations at Meteorological Observatories:—

Fukushima	8h 46m 18s (?) a.m.	Slight.	Houses shaken.
Kumagae	8. 47. 48	,,	
Tokyo	8. 49. 3	,,	
Mito	8. 48. 14	,,	

The P.T. lasted for 14s.

The P.P. There were two maximum movements, of which the first took place at the commencement of this epoch and was 0,03 mm in the EW and 0,01 mm in the NS component. The second maximum occurred 8s later on and was 0,07 mm in the EW and 0,02 mm in the NS component. During the first 30s the motion consisted of quick period vibrations. Then there appeared slower movements of an average period of 2,0s.

The E.P. Towards the end, the average period was about 4,4s.

Eqke No. 194. September 9th 1899; about 9h 46m a.m.

Total duration = about 15m.

This earthquake was observed at no Meteorological Observatory, but probably belongs, as the following earthquake No. 195, to the group III. The motion showed traces of vibrations of an average period of 9,3s.

Eqke No. 195. September 9th 1899; 11h 0m 34s a.m.

Total duration = 42m.

Observations at Meteorological Observatories:—

Akita	10h 55m 32s a.m.	Slight.
Mito	11. 3. 7	,,

(EW component).

The commencement was somewhat obscure owing to the presence of slight P.O. The motion was almost completely free from superposed quick vibrations.

The P.T. lasted for about 42s. The average period was 8,4s.

The P.P. lasted for about 12m. For the first 2m 30s the motion consisted of slow undulations of an average period of 22s, superposed with vibrations of an average period of 9,3s; the amplitude remained nearly uniform, the max. 2a being 0,6 mm. Then there followed, for 2m 41s, quicker vibrations of an average period of 8,9s, the first of which had a max. 2a of 0,8 mm. For the next 38s the motion was most active and had

a max. (abs.) 2a of 0,9 mm, the average period being 8,6s. Towards the end the average period was 7,2s.

The E.P. The average period deduced from three successive groups of 50 vibrations, was as follows:—

8,4s (at the commencement),
8,4
8,4 (at the end).
(General mean) 8,4s.

The NS component diagram was not satisfactory.

Eqke No. 199. September 18th 1899; 11h 6m 56s p.m.
Total duration = 14m.

Observations at Meteorological Observatories:—

Fukushima	11h 2m 25s p.m.	Slight.	
Tokyo	11. 6. 29	„	
Mito	11. 6. 34	„	Doors shaken.
Kumagae	11. 7. 34	„	
Yokohama	11. 7. 52	„	
Choshi	11. 16. 55	„	

The P.T., whose duration was 30s, consisted of very small movements.

The P.P., whose duration was 3m 44s, consisted during the first 1m 30s, of very quick small vibrations (max. 2a = 0,12 mm in the EW and 0,1 mm in the NS component), superposed on slower waves of an average period of 6,9s (max. 2a = 0,1 mm in the EW and 0,14 mm in the NS component). Then there followed well defined vibrations of an average period of 5,1s; the max. (abs.) 2a, which occurred at 2m 30s from the beginning of the earthquake, being 0,15 mm in the EW and 0,2 mm in the NS component.

The motion showed a series of alternations of maximum and minimum groups, the 2nd, 3rd, 4th, 5th and 6th maximum 2a's occurring, in the NS

component, respectively at 1m 28s, 2m 44s, 3m 40s, 4m 37s and 5m 56s after the 1st (abs.) maximum motion.

The E.P. The average period was 3,8s.

Eqke No. 208. October 1st 1899; 11h 55m 22s a.m.
Total duration = 24m.

Observations at Meteorological Observatories:—

Ishinomaki	11h 29m 55s a.m.	Slight.	
Mito	11. 40. 0	"	
Miyako	11. 40. 24	"	
Fukushima	11. 41. 52	"	Houses shaken.
Matsuyama	11. 58. 0	"	

The commencement was obscured by the existence of slight P.O. The P.T. lasted, however, for about 2m 32s and consisted of small vibrations of an average period of 2,2s.

The P.P. began with the max. 2a of 0,07 mm in the EW and 0,06 mm in the NS component. For the first 1m 14s the average period was 10,6s, while during the next 1m 10s it was 7,8s.

Eqke No. 221. Octobber 21st 1899; 10h 8m 9s p.m.
Total duration = 8m.

Observations at Meteorological Observatories:—

Miyako	10h 5m 6s p.m.	Strong.	Motion quick, accompained by vertical movements; houses shaken.
Akita	10. 6. 15	Slight.	Accompanied by vert. mot.
Aomori	10. 7. 30	"	
Ishinomaki ..	10. 8. 31	"	
Tokyo	10. 8. 41	"	
Fukushima ..	10. 13. 9	"	

The motion was small, the max. 2a being 0,04 mm in each component.

The commencement and end of the motion was obscured by the existence of slight P.O.

Eqke No. 223. October 29th 1899; 11h 18m 47s p.m.
Total duration = about 3m.

Observations at Meteorological Observatories:—

Fukushima .. 11h 20m 13s p.m. Slight.

The P.T. lasted for about 12s.

The P.P. consisted of small quick vibrations. The motion was confused by strong P.O.

P.O. began to appear about 7 hours before the earthquake, the max. 2a being 0,07 mm in each component. The average period was 4,6s.

Eqke No. 224. November 3rd 1899; 1h 39m 21s p.m.
Total duration = 29m.

Observations at Meteorological Observatories:

Fukushima .. 1h 35m 6s p.m. Slight.

(NS component).

The motion was small during the first 40s. For the next 2m 15s the waves were well pronounced and had an average period of 6,1s, the max. 2a being 0,04 mm. For the next 1m 40s the motion was again small and had an average period of 11,1s. Then there followed the group of the most active vibrations, which lasted for 4m 22s and had an average period of 6,6s, the max. 2a being 0,05 mm. After this the motion became small.

(EW component).

The P.T. lasted for about 4m 50s and consisted of very small vibrations of an average period of 4,3s superposed on slower waves of an average period of 7,5s. The max. 2a was 0,03 mm.

The P.P. which lasted 6m 6s began with the max. (abs.) 2a of 0,13 mm and had an average period of 8,1s.

Eqke No. 226. November 6th 1899; 7h 53m 47s p.m.
Total duration = 20m.

Observations at Meteorological Observatories:—

Fukushima	7h 54m 46s p.m.	Slight.	

(EW component).

The P.T., whose duration was 2m 0s, consisted of small vibrations of an average period of about 2,8s, superposed on undulations of an average period of 10,0s.

The P.P. lasted 8m. The max. 2a of 0,05 mm occurred at the commencement, but the motion remained sensibly constant in amplitude throughout this epoch. In the earlier part the average period was 4,8s; in the later part it was 7,1s.

(NS component).

The max. 2a was 0,05 mm.

P.O. The vibrations were very small. Their average period, measured a few hours before the earquake, was 4,2s.

Eqke No. 229. November 11th 1899; 2h 40m 24s a.m.
Total duration = 1h.

Observations at Meteorological Observatories:—

Hakodate	2h 39m 14s a.m.	Weak.	Motion quick.
Aomori	2. 40. 0	,,	
Miyako	2. 43. 16	,,	Duration long.
Fukushima	2. 18. 36	Slight.	
Mito	2. 39. 40	,,	
Tokyo	2. 40. 45	,,	
Kushiro	2. 41. 12	,,	Motion quick.
Kumagae	2. 41. 49	,,	
Yokohama	2. 41. 56	,,	Motion quick.
Akita	2. 42. 30	,,	
Kofu	2. 47. 30	,,	Motion quick.
Ishinomaki	2. 51. 5	,,	Houses shaken

(EW component).

The P.T., whose duration was 1m 19s, began with very small movements. The motion consisted of vibrations of an average period of 3,9s, superposed with extremely small waves.

The P.P., whose duration was 9m, consisted during the first 2m 3s of well defined vibrations (max. 2a=0,4 mm) whose average period was 2,9s. During the next 3m 9s, the motion was most active; the max. 2a being 0,55 mm and the average period 4,2s. After this there appeared smaller and slower vibrations of an average period of 7,0s, mixed with others of an average period of 5,3s.

The E.P. The average period was 6,8s.

(NS component).

The P.P. lasted for 1m 8s.

The P.P. The motion was most active during the first 4m 40s, the predominating average period being 3,4s. The max. 2a of 0,85 mm occurred at 3m 8s from the beginning of the earthquake.

Eqke No. 230. November 11th 1899; 7h 10m 0s a.m.

Total duration=35m.

Observations at Meteorological Observatories:—

Aomori	7h 10m 20s a.m.	Slight.
Fukushima	7. 6. 29	„
Miyako	7. 13. 28	„

(EW component).

The P.T., whose duration was 1m 30s, consisted of small vibrations of an average period of 7,9s.

The P.P., whose duration was 7m 10s, consisted during the first 1m 28s of small vibrations (max. 2a=0,08 mm) of an average period of 5,9s. During the next 3m 3s, the motion was most active; the max. 2a being 0,15 mm and the average period 6,1s. In the earlier and the later parts of this epoch there were also traces of small vibrations of an average period of 2,7s.

The E.P. consisted of regular vibrations of an average period of 8,1s.

(NS component).

The max. 2a was 0,15 mm.

Eqke No. 239. December 10th 1899; 11h 22m 21s p.m.

Total duration=1h.

Observations at Meteorological Observatories:—

Tokyo	11h 22m 19s p.m.	Slight.	
Mito	11. 22. 30	„	
Yokosuka ..	11. 22. 30	„	
Maebashi	11. 22. 39	„	
Kofu	11. 26. 21	„	Motion quick.

(EW component).

The P.T., whose duration was 1m 12s, consisted of small quick movements superposed on traces of slower vibrations of an average period of 3,8s.

The P.P. consisted for the first 1m 25s of quick vibrations (max. 2a =0,1 mm) superposed on slow undulations of an average period of 17,0s, of which the first had a max. 2a of 0,5 mm. The superposed small vibrations then disappeared, and for the next 1m 20s the motion consisted of well defined vibrations (max. 2a=0,15 mm) of an average period of 3,0s. During the next 3m 50s, the average period was 4,9s (max. 2a=0,25 mm). On all these latter vibrations traces of waves of an average period of about 10s were superposed more or less definitely. Later on the average period was 9,3s.

The E.P Towards the very end the average period was 8,3s.

(NS component).

The P.T. lasted for 1m 5s. There were traces of waves of an average period of 8,1s (?)

The P.P. commenced with small quick movements superposed on slow undulations of an average period of 19s whose second vibration had the

max. 2a of 0,55 mm. The various periods which occurred during the P.P. were as follows :—

quickest vibrations	(max. 2a = 0,2 mm);
4,9s	(max. 2a = 0,25 mm);
10,8	(max. 2a = 0,25 mm).

Eqks No. 240. December 12th 1899; 3h 43m 27s p.m.

Total duration = 16m.

Observations at Meteorological Observatories :—

Fukushima	3h 43m 8s p.m.	Slight.
Tokyo	3. 43. 51	„
Mito	3. 45. 15	„

The P.T. lasted for about 35s (?). The commencement of the motion was confused by slight P.O.

The P.P. The average period was 7,8s, and the max. 2a was 0,04 mm in each component.

GROUP IV.—*Earthquakes which originated off the coasts of the provinces of Hitachi and Iwaki.*

Eqke No. 3. July 15th 1898; 5h 10m 22s a.m.
Total duration = 6m.

Observations at Meteorological Observatories :—

Mito	5h 8m 34s a.m.	Slight.	Motion quick.
Fukushima	5. 9. 45	,,	Motion gentle
Choshi	5. 9. 53	,,	
Tokyo	5. 10. 44	,,	
Kumagae	5. 10. 48	,,	
Maebashi	5. 10. 55	,,	
Utsunomiya	5. 11. 0	,,	Motion gentle
Kofu	5. 12. 47	,,	

The P.T., whose duration was 19s, consisted of vibrations of an average period of 1,2s, superposed with very quick small waves.

The P.P., whose duration was 21s, consisted essentially of vibrations of an average period of about 1,1s. The max. 2a was 0,16 mm iu the EW and 0,20 mm in the NS component.

The E.P. The average period was 2,7s.

Eqke No. 20. August 22nd 1898; 11h 31m 53s p.m.
Total duration = 6m 20s.

Observations at Meteorological Observatories :—

Nagano	11h 13m 41s p.m.	Slight.	
Fukushima	11. 37. 49	,,	Motion gentle.
Utsunomiya ..	11. 40. 0	,,	
Maebashi	11. 40. 8	,,	Motion gentle.

Kumagae	11h 40m 14s p.m.	Slight.
Tokyo	11. 10. 33	,,
Mito	11. 41. 5	,,
Kofu	11. 41. 20	,,
Miyako	11. 41. 21	,,
Ishinomaki	11. 41. 50	,,

The P.T. lasted for 17s.

The P.P. consisted essentially of quick waves of an average period of 1,0s, superposed on slower ones of an average period of 3,0s. The max. 2a was 0,05 mm in the EW and 0,04 mm in the NS component.

In the E.P. the average period was 2,9s.

Eqke No. 20. August 23rd 1898; 11h 42m 53s a.m.
Total duration = 3m 24s.

This earthquake was observed at no meteorological observatory, but seems to have originated at the same place as the following earthquake, No. 21. The motion was very small.

The average period, measured towards the end, was 2,0s.

Eqke No. 21. August 23rd 1898; 11h 47m 17s a.m.
Total duration = 8m.

Observations at Meteorological Observatories:—

Fukushima	11h 46m 25s a.m.	Slight.	
Mito	11. 46. 32	,,	
Kumagae	11. 46. 42	,,	
Utsunomiya	11. 47. 42	,,	Motion gentle.
Tokyo	11. 47. 59	,,	
Maebashi	11. 51. 0	,,	

The P.T. lasted for 17s.

The P.P., whose duration was 49s, began with quick vibrations. 39s later there appeared well defined larger waves, whose average period was

3,6s and whose max. 2a of 0,04 mm in each component occurred at 56s from the commencement of the earthquake.

The E.P. The average period was 3,3s.

Eqke No. 32. September 16th 1898; 8h 32m 40s a.m.
Total duration = 12m.

Observations at Meteorological Observatories:—

Mito	8h 32m 25s a.m.	Weak.	Motion quick houses shaken.
Matsumoto	8. 30. 59	Slight.	
Choshi	8. 31. 50	„	
Utsunomiya ..	8. 32. 10	„	Motion gentle.
Ishinomaki	8. 32. 10	„	
Maebashi	8. 32. 21	„	Motion gentle.
Kumagae	8. 32. 34	„	„
Tokyo	8. 32. 42	„	
Fukushima	8. 32. 50	„	
Yokohama	8. 32. 51	„	Motion gentle.

The P.T. lasted for 16s.

The P.P. consisted of quick vibrations superposed on slower undulations. The max. 2a was 0,3 mm in each component.

The E.P. The average period was 3,8s.

Eqke No. 37. September 27th 1898; 10h 19m 52s a.m.
Total duration = 16m.

Observations at Meteorological Observatories:—

Tokyo	10h 19m 59s a.m.	Slight.	
Mito	10. 20. 51	„	Motion gentle.
Kumagae	10. 39. 20 (?)	„	

The P.T. was not well defined. During the first 58s, however, the motion consisted of small quick vibrations, superposed on waves of an

average period of about 3,0s. The max. 2a was 0,04 mm in the EW and 0,02 mm in the NS component. Towards the end the average period was 5,7s.

Eqke No. 39. September 28th 1898; 7h 53m 40s a.m.

Total duration = 9m.

Observations at Meteorological Observatories :—

Mito	7h 54m 22s a.m.	Slight.

The P.T. lasted for about 30s.

The P.P. consisted of very small vibrations (period about 0,8s) superposed on well defined ones of an average period of 2,2s. The max. 2a was very small in each component.

The E.P. The average period was 3,8s.

Eqke No. 63. November 28th 1898; 10h 56m 10s p.m.

The motion was very small.

Observations at Meteorological Observatories :—

Mito	10h 55m 0s p.m.	Slight.	Motion quick.
Tokyo	10. 56. 10	„	
Fukushima	10. 56. 30	„	

Eqke No. 92. February 22nd, 1899; 8h 2m 18s a.m.

Total duration = 16m.

Observations at Meteorological Observatories :—

Maebashi	7h 1m 56s a.m.	Slight.	
Tokyo	8. 2. 38	„	
Utsunomiya	8. 3. 0	„	Motion gentle.
Choshi	8. 2. 10	Rather strong.	Motion quick; doors shaken.
Mito	8. 3. 44	Weak.	
Kumagae	8. 2. 57	Slight.	
Nagano	8. 3. 2	„	
Fukushima	8. 3. 45	„	Houses shaken.

(EW component).

The P.T., whose duration was 14s, consisted of small vibrations. The max. 2a was 0,05 mm.

The P.P., whose duration was 3m 50s, began with slower waves of an average period of 4,0s, the first motion being 0,2 mm. 21s later there appeared 5 well defined larger vibrations which together lasted for 16,4s and had an average period of 3,3s; the 2nd motion having the max. 2a of 0,65 mm. For the next 2m 5s, the motion was smaller, but the average period was nearly the same as before, namely 3,2s. During the remainder of this epoch, the predominating average period was 6,7s. The quick and small superposed movements continued till 1m 57s after the commencement of the earthquake.

The E.P. The motion consisted at first of vibrations of an average period of 3,4s superposed more or less distinctly on slower ones of an average period of 6,7s. Towards the end the average period was 4,2s.

(NS component).

Here the 1st and 2nd P.T.'s may be distinguished.

The 1st P.T. lasted for 12,8s.

The 2nd P.T. lasted for 8s.

The P.P. began with slow vibrations of an average period of 4,0s, whose 3rd vibration had the max. 2a of 0,45 mm.

P.O. There existed well pronounced slow P.O., whose max. 2a was 0,06 mm in each component. The average period, measured immediately before the earthquake, was 7,3s.

Eqke No. 109. March 22nd 1899; 8h 22m 2s p.m.

Total duration = about 5m.

Observations at Meteorological Observatories :—

Ishinomaki	8h 14m 33s p.m.	Slight.	
Fukushima	8. 15. 10	„	Houses shaken.
Mito	8. 15. 14	„	Motion gentle.
Tokyo	8. 15. 37	„	

Yokohama	8h 16m 1s p.m.	Slight,
Utsunomiya	8. 16. 13	„
Yokosuka	8. 23. 19	„

This was a small shock, the diagram showing only traces of minute quick vibrations.

Eqke No. 115. March 26th 1899; 6h 46m 45s a.m.
Total duration = 15m.

Observations at Meteorological Observatories :—

Fukushima	6h 47m 55s a.m.	Weak.	Houses shaken.
Mito	6. 46. 37	„	Motion quick.
Yokohama	6. 46. 48	„	Motion gentle.
Tokyo	6. 46. 53	„	Motion quick.
Kumagae	6. 41. 31	Slight.	
Nagoya	6. 44. 8	„	
Kofu	6. 45. 15	„	Motion gentle.
Yokosuka	6. 45. 50	„	
Yamagata	6. 45. 52	„	Doors shaken.
Hikone	6. 46. 37	„	
Choshi	6. 46. 50	„	Motion gentle.
Mayebashi	6. 46. 54	„	Accompanied by vertical motion.
Utsunomiya	6. 47. 10	„	Motion gentle.
Akita	6. 47. 20	„	Duration long.
Miyako	6. 49. 2	„	
Ishinomaki	6. 51. 42	„	Houses shaken.

The P.T., whose duration was 16s, consisted of small quick vibrations.

The P.P., whose duration was about 4m, began with two well defined slow vibrations, whose average period was 8,5s and whose 2a was 0,6 mm in each component. These were superposed with quick small movements

(0,3 mm in each component) which ceased to exist at 1m 45s after the commencement of the earthquake. Then there appeared a new groups of 10 large well defined vibrations, which together lasted for 1m 0s and had an average period of 6,0s; the max. 2a being 0,6 mm in the EW and 0,3 mm in the NS component. For the next 1m 21s, there were 25 quicker vibrations of an average period of 3,2s; the max. 2a being 0,32 mm in the EW and 0,25 mm in the NS component.

The E.P. The motion consisted of regular vibrations, whose average period was about 7,0s. The end was confused by P.O.

P.O. P.O. existed both on the 25th and 26th. The amplitude remained nearly constant, on the whole; the period was however gradually lengthened with time. The max. 2a was 0,15 mm in each component. The average period was as follows:—

7,3s (on the 26th, morning);
4,9 („ 25th, „).

Eqke No. 123. April 15th 1899; 0h 40m 26s a.m.

Total duration = 7m.

Observations at Meteorological Observatories:—

Mito	0h 41m 17s a.m.	Slight.
Tokyo	0. 41. 45	„
Choshi	0. 59. 11 (?)	„

The P.T. lasted for 1m 2s.

The P.P. consisted for the first 38s of small quick vibrations superposed on waves of an average period of 4,8s. Then followed the group of the most active vibrations of an average period of 3,4s; the max. 2a being 0,04 mm in the EW and 0,05 mm in the NS component.

The E.P. Towards the end the average period was 3,4s.

P.O. There existed very slight traces of P.O. The average period, measured on the morning of the 14th, was 3,7s.

Eqke No. 174. August 1st 1899; 9h 39m 57s a.m.

Total duration = 6m.

Observations at Meteorological Observatories :—

Mito	9h 39m 0s a.m.	Weak.	Accompanied by vertical motion; houses shaken.
Kumagae	9. 38. 0	Slight.	Motion quick.
Utsunomiya	9. 38. 30	"	"
Maebashi	9. 38. 53	"	Motion gentle.
Tokyo	9. 38. 55	"	
Yokohama	9. 38. 56	"	Motion quick.
Fukushima	9. 39. 10	"	

The P.T. lasted for 7s.

The P.P., whose duration was 65s, consisted of small quick vibrations, the motion commencing with the max. 2a of 0,15 mm in the EW and 0,13 mm in the NS component. In the former component the amplitude remained nearly constant for about 25s; but in the NS component there was a second max. 2a of 0,17 mm at 6s after the first maximum.

Eqke No. 175. August 3rd 1899; 1h 34m 52s a.m.

Total duration = 10m.

Observations at Meteorological Observatories :—

Mito	1h 34m 46s a.m.	Weak.	Motion quick; accompanied by vertical movements; houses shaken.
Matsuyama	1. 31. 30	Slight.	Motion quick.
Matsumoto	1. 32. 18	"	
Miyako..	1. 34. 9	"	
Maebashi	1. 35. 1	"	Motion gentle.
Tokyo	1. 35. 5	"	
Yokohama	1. 35. 11	"	
Fukushima	1. 35. 14	"	Motion quick; doors shaken.
Kumagae	1. 35. 18	"	Motion quick.
Utsunomiya ..	1. 35. 38	"	
Choshi	1. 40. 26	"	

The P.T. lasted for 17s. In the NS component the amplitude remained nearly uniform. But in the EW component there was an abrupt increase of amplitude at 8s from the commencement.

The P.P., whose duration was 45s, consisted of small quick vibrations; the max. 2a being 0,18 mm in tne EW and 0,14 mm in the NS component.

The E.P. At first the motion consisted of vibrations of an average period of 2,8s, superposed on traces of slower ones. Towards the end the vibrations were regular and had an average period of 5,0s.

Eqke No. 178. August 5th 1899; 9h 18m 53s a.m.
Total duration = 8m.

Observations at Meteorological Observatories :—

Mito	9h 18m 43s a.m.	Weak.	Motion quick; accompanied by vertical movements; houses shaken.
Utsunomiya ..	9. 19. 0	"	Motion quick.
Ishinomaki ..	9. 12. 40 (?)	Slight.	
Choshi	9. 18. 26	"	Motion gentle.
Fukushima ..	9. 18. 53	"	
Kumagae ..	9. 19. 1	"	
Tokyo	9. 19. 19	"	

The P.T., whose duration was 26s, consisted of small quick vibrations.

The P.P., whose duration was 40s, began with the max. 2a of 0,1 mm in the EW and 0,05 mm in the NS component. The period was very short.

The E.P. The average period was 3,3s, there being also traces of still quicker vibrations.

P.O. The max. 2a was very short. The average period was 6,6s.

Eqke No. 182. August 13th 1899; 8h 0m 2s p.m.

Total duration = 4m.

Observations at Meteorological Observatories:

Tokyo . . .	8h 0m 16s p.m.	Slight.	
Mito	8. 0. 56	Weak.	Motion quick: houses shaken.
Fukushima . .	8. 1. 36	Slight.	Houses shaken.

(NS component).

The P.T. lasted for 15s.

The P.P. began with a well defined motion towards S; the counter displacement (max.) being 0,07 mm, directed towards N.

The EW component diagram was obscured by the superposition of lines.

Eqke No. 204. September 27th 1899; 1h 57m 39s a.m.

Total duration = 4m 30s.

Observations at Meteorological Observatories:—

Utsunomiya . .	1h 57m 20s a.m.	Weak.	Motion gentle.
Mito	1. 57. 35	„	Motion quick; accompanied by vertical movements; houses shaken.
Choshi	1. 57. 43	Slight.	
Ishinomaki . .	1. 57. 59	„	

The P.T. lasted for 7s.

The P.P., whose duration was 20s, consisted of quick vibrations. The max. 2a was 0,15 mm in the EW and 0,08 mm in the NS component.

Eqke No. 209. October 3rd 1899; 6h 28m 3s p.m.

Total duration = about 6m.

Observations at Meteorological Observatories:—

Fukushima	6h 27m 19s p.m.	Slight.	Houses shaken.
Mito	6. 27. 38	,,	Doors shaken.
Tokyo	6. 28. 19	,,	
Utsunomiya	6. 28. 30	,,	Motion gentle

The P.T. lasted for about 6s.

The P.P. consisted of very small quick vibrations. The max. 2a was 0,04 mm in the EW and 0,03 mm in the NS component and occurred towards the end of this epoch.

The E.P. The average period was about 3,3s.

Eqke No. 215. October 10th 1899; 6h 47m 26s p.m.

Total duration = 3m.

Observations at Meteorological Observatories :—

Mito	6h 47m 17s p.m.	Weak.	Duration long.
Utsunomiya	6. 47. 23	,,	Motion quick.
Tokyo	6. 47. 43	Slight	
Kumagae	6. 47. 49	,,	Motion quick.
Fukushima	6. 51. 18	,,	Houses shaken.

The P.T., whose duration was 23s, consisted of very small quick vibrations.

The P.P., whose duration was 25s, began with a motion directed towards NE; the counter displacement (max.) being 0,12 mm towards W and 0,14 mm towards S. The average period of the most active vibrations was about 6,5s, there being also traces of small quicker ones. In the EW component the amplitude remained nearly constant. But in the NS component, there were three distinct maximum groups of vibrations with nearly an equal range of motion, of which the two last began respectively at 4,7s and 7,3s after the first.

The E.P. The average period was 1,9s.

Eqke No. 242. December 20th 1899; 10h 46m 29s a.m.

Total duration = 13m.

Observations at Meteorological Observatories :-

Mito	10h 46m 45s a.m.	Weak.	Accompanied by vertical motion; houses shaken.
Yokohama ..	10. 48. 6	„	Motion quick.
Ishinomaki ..	10. 46. 5	Slight.	
Kumagae ..	10. 47. 15	„	
Kofu	10. 47. 37	„	Motion gentle.
Tokyo	10. 47. 52	„	Motion quick.
Maebashi ..	10. 49. 1	„	
Fukushima ..	10. 42. 25	„	Houses shaken.
Miyako ..	10. 48. 27	„	
Akita	10. 57. 45	„	

The P.T., whose duration was 24s, consisted of small quick vibrations.

The P.P. began with two small vibrations. The 3rd vibration was the maximum (abs.), its 2a being 0,17 mm in the EW and 0,44 mm in the NS component. The motion was quick-perioded during the first 1m 35s, the average period being 1,5s.

The E.P. Towards the end the average period was 4,1s.

Eqke No. 246. December 31st 1899; 9h 40m 17s a.m.
Total duration $=3\frac{1}{2}$m.

Observations at Meteorological Observatories :—

Maebashi	9h 40m 4s a.m.	Slight.	
Utsunomiya ..	9. 40. 6	„	
Kofu	9. 40. 28	„	Motion gentle.
Ishinomaki ..	9. 41. 28	„	Duration short.
Iida	9. 46. 20	„	
Fukushima ..	9. 50. 14	„	Motion gentle.

The duration of the P.T. was uncertain, on account of the existence of P.O.

(NS component).

The P.P. began with the max. 2a of 0,3 mm.

The EW component diagram was lost, as the earthquake took place during the change of the record-receiver.

P.O. The P.O., whose max. 2a was 0,2 mm in each component, was active on the 30th, but lessened very much before the occurrence of the earthquake. The average period was 5,0s.

GROUP V.—*Earthquakes which originated off the southern coast of Honshiu (Main Island).*

Eqke No. 99. March 7th 1899; 9h 55m 29s a.m.
Total duration = 1¼h.

This was a large earthquake, whose total land area of disturbance was about 240,000 square km. and whose origin was situated off the south-eastern coast of the province of Kii, at about long. 136° 26′ E and lat. 33° 45′ N. The shock was most strongly felt in the middle and southern parts of the province of Yamato and in the eastern part of the province of Kii, where, amongst others, numerous land-slips took place, killing a few and wounding a great many people. In the city of Osaka some brick buildings were damaged and a few small chimneys were broken.

Observations at Meteorological Observatories :—

Nagoya ..	9h 54m 35s a.m.	Strong.	Motion quick and accompanied by vertical movements; houses shaken.
Gifu ..	9. 54. 49	,,	Accompanied by vertical motion; houses shaken.
Kobe ..	9. 54. 50	,,	Pendulum clocks stopped.
Kyoto ..	9. 55. 1	,,	Accompanied by vertical motion; pendulum clocks stopped.
Tokushima	9. 55. 46	,,	Accompanied by vertical motion; houses shaken.
Tsu ..	9. 56. 28	,,	Accompanied by vertical motion; pendulum clocks stopped; followed by after-shocks.

Osaka	9h 56m 36s a.m.	Strong.	Motion quick, accompanied by vertical movements; li-quids overflowed.
Hikone	10. 0. 0	„	Motion quick, accompanied by vertical movements; houses shaken.
Hamamatsu ..	9. 54. 40	Rather strong.	Pendulum clocks stopped; followed by after-shocks.
Sakai (in Hoki)	9. 55. 18	Strong.	Houses shaken.
Yagi	9. 57. 47	„	Motion quick; verticat motion strongly felt; walls cracked.
Wajima .. .	9. 58. 10	„	Houses shaken.
Wakayama ..	10. 5. 0	„	Pendulum clocks stopped.
Tadotsu . ..	9. 57. 35	Rather strong.	Accompanied by vertical motion and earthquake sound; pendulum clocks stopped.
Fukui	9. 54. 0	Weak.	Motion quick; accompanied by vertical motion; pendulum clocks stopped.
Yokohama ..	9. 54. 58	„	Duration long.
Nagatsuro ..	9. 54. 30	„	Houses shaken.
Fushiki	9. 55. 0	„	
Kofu	9. 55. 31	„	Motion quick; accompanied by vertical movements; houses shaken.
Kochi	9. 57. 44	„	Doors shaken.
Iida	9. 53. 24	„	Motion quick; accompanied by vertical movements; houses shaken.

Okayama .	10h	0m	50s a.m.	Weak.	Motion quick; accompanied by vertical movements; pendulum clocks stopped.
Matsumoto ..	9.	54.	51	,,	Duration long.
Nagano	9.	55.	1	,,	
Kumagae ..	9.	55.	36	,,	Motion gentle.
Kanazawa ..	9.	57.	0	,,	Pendulum clocks stopped.
Hiroshima ..	9.	59.	0	,,	Motion gentle.
Oita	9.	59.	20	,,	Doors shaken.
Numazu ..	9.	52.	48	,,	Pendulum clocks stopped.
Kure	9.	55.	26	Slight.	Motion gentle.
Tokyo	9.	55.	29	,,	,,
Mito	9.	56.	20	,,	Only instrumentally registered.
Mayebashi ..	9.	56.	25	,,	Motion gentle.
Choshi	9.	56.	41	,,	,,
Izugahara ..	9.	57.	0	,,	,,
Kagoshima ..	9.	59.	0	,,	,,
Oshima	9.	59.	11	,,	,,
Shiwonomisaki	10.	0.	15	,,	Motion quick, accompanied by vertical motion.
Fukuoka ..	9.	57.	13	,,	
Saga	10.	0.	0	Weak.	Duration long.
Matsuyama ..	10.	0.	30	Slight.	
Kumamoto ..	10.	1.	26	,,	Duration long.
Hamamatsu ..	10.	1.	20	..	..

(EW component).

The earthquake began with a displacement of 0,2 mm towards E, the counter motion being 0,45 mm towards W. The second and third undulations were as follows :—

(2nd wave.) 1st displacement 0,7 mm towards E, counter displacement 1,85 mm towards W; period 13,7 sec.

(3rd wave.) 1st displacement 3,65 mm towards E, counter displacement 4,15 mm towards W; period 17,8s.

These three undulations together occupied 45,7s and may be taken as the P.T. Then larger and quicker motion began to appear, the first three vibrations giving an average period of 9,4s. Then the max. 2a of 15,9 mm, (period 9,4s) took place. The subsequent motion was much smaller, and complex owing to the appearance of slow undulations of an average period of 33s. Superposed on these latter there were vibrations of an average period of 7,5s. The P.P. lasted for 6m 44s.

The E.P. The average period, deduced from 8 successive groups of 50 vibrations, was as follows:—

6,5s	(at the commencement)	
7,0		
7,9		
8,0		(General mean) 8,0s.
8,5		
9,0		
8,8		
8,7	(towards the end)	

For two minutes at the commencement of the earthquake there were also traces of quick small vibrations, whose principal average period was about 2,3s.

(NS component).

The NS component diagram was imperfect as the earthquake took place during the change of the record-receiver.

Eqke No. 100. March 7th 1899; 3h 42m 50s p.m.

Duration = 9m.

Observations at Meteorological Observatories:—

Tsu	3h 40m 25s p.m.	Weak.	Accompanied by vertical motion.

[illegible].	3h 48m 37s p.m.	Weak.	Accompanied by vertical motion; houses shaken.
Mikoa.	3. 15. 5	Slight.	
Wakayama.	3. 40. 20	,,	Accompanied by vertical motion.
Sakai ..	3. 40. 49	,,	
Kofu ..	3. 40. 58	,,	
Hamamatsu	3. 41. 0	,,	Motion quick.
Kyoto ..	3. 41. 29	,,	
Nagoya ..	3. 41. 30	,,	Motion gentle.
Matsumoto.	3. 41. 38	,,	
Nagano ..	3. 41. 54	,,	
Tadotsu ..	3. 44. 17	,,	Motion gentle.
Fushiki ..	3. 48. 37	,,	
Tokushima.	3. 4. 0	,,	

The P.T. lasted for 1m 21s. During the first 24s, which may probably be taken as the 1st P.T., the motion was very small. During the remainder of this epoch, the motion consisted of vibrations of an average period of 6,4s, superposed with quicker ones of an average period of 2,6s, which latter waves became more prominent towards the end.

The P.P. began with the maximum group of vibrations of an average period of 7,0s, superposed with small quick vibrations of an average period of 2,6s. The max. 2a was 0,09 mm in the EW and 0,07 mm in the NS component.

The E.P. was obscured by P.O.

P.O. The average period, measured 3 hours after the earthquake, was 6,4s.

Eqke No. 119. April 6th 1899; 8h 30m 22s a.m.

Total duration = about 19m.

This was a small earthquake at some distance and was felt as a slight shock throughout a rather large area, which extends from the province of

Rikuzen on the north to the provinces of Echizen, Bizen and Sanuki on the south-west.

Observations at Meteorological Observatories

Gifu	8h 25m 1s a.m.	Slight.	
Yagi	8. 25. 30	„	
Okayama ..	8. 27. 00	„	
Wakayama ..	8. 27. 50	„	Motion gentle.
Tsu	8. 28. 17	„	Duration long.
Fukui	8. 28. 57	„	
Fukushima ..	8. 29. 19	„	
Tadotsu .	8. 29. 24	„	
Osaka	8. 29. 32	„	Motion gentle.
Maebashi ..	8. 30. 3	„	
Yokohama ..	8. 30. 8	„	Motion gentle.
Kumagae ..	8. 80. 12	„	
Nagano . ..	8. 30. 20	„	
Tokyo ..	8. 30. 22	„	
Mito	8. 30. 25	„	
Kofu	8. 30. 58	„	Motion gentle.
Kobe	8. 33. 00	„	
Ishinomaki ..	8. 33. 6	„	Accompanied by sound; liquids overflowed.
Choshi	8. 33. 8	„	
Utsunomiya ..	8. 42. 00	„	

The P.T., whose duration was 49s in the EW and 46s in the NS component, consisted of vibrations of an average period of 7,7s; the maximum motion of 0,2 mm in the EW and 0,14 mm in the NS direction occurring at the very beginning of the earthquake. There were also traces of quick small vibrations of an average period of 2,2s, whose max. 2a was 0,25 mm in each component.

The P.P., whose duration was 7¼m, began with the max. (abs.) 2a of 0,42 mm in the EW and 0,32 mm in the NS component, with a period of

[illegible]. After about 1m there appeared well defined waves of an average period of 7,8s, whose greatest motion was 0,35 mm in the EW and 0,29 mm in the NS component.—In the earlier part of this epoch the motion was superposed with small quick vibrations of an average period of 2,6s.

The E.P. was confused by P.O.

GROUP VI.—*Earthquakes which originated in the Island of Kiushiu or off its eastern coast.*

Eqke No. 12. August 10th 1898; 10h 0m 50s p.m.
Total duration = about 9½m.

The meizoseismal area, in which buildings were damaged, landslips produced, etc., was a limited portion of the west of the province of Chikuzen (in the northern part of Kiushiu) about 900 km WSW of Tokyo.

Observations at Meteorological Observatories:—

Fukuoka	9h 57m 31s p.m.	Strong.
Izugahara . .	9. 30. 30	Weak.
Sakai (in Hoki)	9. 55. 28	,,
Kumamoto . .	9. 55. 39	,,
Akamagaseki .. .	9. 57. 56	,,
Saga	9. 58. 50	Slight.
Miyazaki		,,
Matsuyama . .	9. 57. 0	,,
Oita	9. 57. 7	,,
Tadotsu	9. 57. 47	..

The P.T. lasted for about 22s and consisted of vibrations of an average period of 3,7s. The beginning was, however, not well defined and a portion of the P.T. was probably lost.

The P.P. The max. 2a was 0,15 mm in each component, the average period being 7,2s.

The E.P. The average period was 3,7s.

Eqke No. 14. August 12th 1898; 8h 38m 42s a.n
Total duration = about 30m.

This earthquake originated approximately in the same locality as, but was stronger than, the preceding one.

Observations at Meteorological Observatories :—

Saga	8h 34m 29s a.m.	Strong.
Fukuoka	8. 35. 34	„
Sasebo	8. 36. 26	„
Akamagaseki	8. 36. 8	Weak.
Sakai (in Hoki) ..	8. 34. 49	„
Oita	8. 36. 12	„
Kumamoto	8. 36. 25	„
Izugahara	8. 36. 13	Slight.
Tadotsu	8. 36. 55	„
Fukui	8. 38. 15	„

The P.T. lasted for 122s. The average period was 3,7s.

The P.P. began with 15 well defined vibrations of an average period of 3,7s, whose max. 2a was 0,2 mm in the EW and 0,1 mm in the NS component. Then followed 30 slower waves of an average period of 7,0s, whose max. 2a was 0,4 mm in the EW and 0,2 mm in the NS component.

The E.P. The average period deduced from two successive groups of 60 vibrations taken at the end was as follows :—

	(General mean)
7,0s	7,6s.
8,1	

Eqke No. 66. December 4th 1898 : 1h 45m 32s a.m.

Total duration = about 19m.

The earthquake was felt strongly in the northern part of Kiushiu, the epicentre being at about long. 139° E and lat. 33° N.

Observations at Meteorological Observatories :—

Oita	1h 44m 28s a.m.	Strong.	Motion quick, accompanied by vertical movements; pendulum clocks stopped.

Saga	1h 35m 38s a.m.	Strong.	Duration long.
Kumamoto ..	1. 49. 27	,,	Motion quick, accompanied by vertical movements; houses shaken.
Hiroshima ..	1. 44. 00	Weak.	Motion gentle.
Miyazaki ..	1. 44. 00	,,	Accompanied by vertical motion; pendulum clocks stopped.
Kagoshima ..	1. 45. 3	,,	Houses shaken.
Fukuoka ..	1. 45. 20	,,	Motion quick, accompanied by vertical motion; houses shaken.
Tadotsu ..	1. 45. 27	,,	Accompanied by sound; houses shaken.
Kochi	1. 45. 40	,,	Houses shaken.
Kure	1. 46. 0	,,	Duration long.
Akamagaseki.	1. 46. 26	,,	Duration short.
Osaka	1. 47. 33	,,	Duration long.
Matsuyama ..	1. 49. 50	,,	Houses shaken.
Fukui	1. 45. 27	Slight.	
Tsu	1. 46. 25	,,	
Sakai	1. 45. 30	,,	Motion gentle.
Yagi	1. 46. 48	,,	,,
Hamada ..	1. 47. 0	,,	Motion quick, accompanied by vertical movements.
Nagasaki ..	1. 50. 16	,,	Duration long.
Okayama ..	1. 52. 4	,,	
Tokyo	1. 57. 0	,,	

(NS component).

The P.T. The beginning and end of the diagram were obscured by small and quick P.O., whose max. 2a was 0,04 mm and whose average period was 4,4s (measured immediately before the earthquake). The

duration of the P.T. was about 1m 24s. Towards the end there were traces of distinct waves of an average period of 8,2s.

The P.P. whose duration was about 9m began with 7 oscillations of an average period of 9,3s; of these the 4th was the (abs.) maximum, its 2a being 1,0 mm. For the next 1m 11s predominating waves had an average period of 4,4s, the max. 2a of 0,55 mm occurring at 3m 20s from the commencement of the earthquake. For the next 7m 50s the motion was more or less active, consisting essentially of waves of an average period of 8,5s.

The E.P. The average period was 7,5s.

(EW component).

The P.T. lasted for about 112s. There were traces of vibrations of an average period of 9,0s.

The P.P., whose duration was about 9m 18s, began with vibrations of an average period of 6,5s (max. 2a = 0,7 mm), superposed on slower ones of an average period of 9,4s (max. 2a = 0,55 mm). In the subsequent part the predominating period was 7,7s.

The E.P. The average period was about 8,0s.

Eqke No. 112. March 24th 1899; 1h 2m 35s p.m.
Total duration = 1h 9m.

The earthquake was felt strongly in the eastern half of Kiushu, the origin being probably situated off its eastern coast, at about longitude 132° E and lat. 32° N.

Observations at Meteorological Observatories :—

Miyazaki ..	1h 0m 0s p.m.	Strong.	Motion quick, accompanied by vertical movements houses shaken.
Kagoshima ..	1. 0. 35	„	
Oita	1. 0. 47	„	Accompanied by sound and vertical motion; pendulum clocks stopped.

Tokushima ..	0h 57m 30s p.m.	Weak.	Motion quick, accompanied by vertical movements.
Kumamoto ..	1. 0. 51	„	Motion quick, accompanied by vertical movements; houses shaken.
Tadotsu	1. 1. 22	„	„ „
Fukuoka	1. 1. 25	„	Houses shaken.
Akamagaseki ..	1. 1. 33	„	Accompanied by vertical motion.
Hiroshima ..	1. 2. 0	„	Duration long.
Sakai	1. 3. 15	„	Motion gentle.
Nagasaki	1. 3. 44	„	Duration long.
Oshima	1. 4. 20	„	„ „
Tsu	0. 57. 35	Slight.	
Fukui	0. 59. 59	„	Duration long.
Osaka	1. 0. 6	„	„ „
Saga	1. 0. 13	„	„ „
Wakayama ..	1. 1. 2	„	Motion gentle.
Kochi	1. 1. 36	„	„ „
Yagi	1. 1. 40	„	Duration long.
Kure	1. 1. 45	„	Motion gentle.
Matsuyama ..	1. 2. 10	„	
Nagano	1. 2. 35	„	
Kyoto	1. 2. 45	„	
Izugahara ..	1. 2. 50	„	
Nagoya	1. 2. 50	„	Accompanied by vertical motion.
Gifu	1. 2. 54	„	Motion gentle.
Okayama ..	1. 3. 33	„	„ „
Tokyo	1. 4. 57	„	

(NS component).

The P.T., which lasted for 2m 2s, consisted of small quick vibrations

of an average period of 2,4s. During the last 44s, however, which may probably be taken as the 2nd P.T., there were larger vibrations of an average period of 3,7s. Throughout this epoch there were well defined traces of slower waves of an average period of 8,4s.

The P.P., whose duration was about 15m, began with nine regular well pronounced vibrations (max. 2a=0,9 mm) lasting together for 1m 21s and having an average period of 9s. For the next 1m 39s, the motion consisted of slow undulations of an average period of 16,5s, the max. (abs.) 2a being 1,3 mm. The motion remained small during the next 2m 12s, and then took place two conspicuous undulations (2a=0,6 mm) of an average period of 15,5s. After this the motion showed a series of alternations of max. and min. groups, the average interval between successive maxima being 1m. Towards the end, the average period was 9,9s.

The E.P. The average period, deduced from two successive groups of 50 vibrations, was as follows:—

9,0s	(General mean)
8,6	8,8s.

(EW component).

The P.T. lasted for 1m 40s. The principal average period was at first 2,9s, but towards the end 8,8s.

Then P.P. began with two slow undulations of an average period of 26,5s, of which the first had a max. 2a of 1,2 mm. Superposed on these there were well defined waves (max. 2a=0,8 mm) of an average period of 8,4s.

Eqkes Nos. 236 and 237. November 25th 1899; 3h 45m 24s a.m. and 3h 58m 48s a.m.

Total duration=2h 13m.

The first of these two earthquakes was the greatest which shook Kiushiu in recent years. In the two provinces of Bungo and Hiuga a few houses were overthrown and the ground was slightly cracked. The origin was probably inland, at about long. 131°¼ E and lat. 32°¾ N.

Observations at Meteorological Observatories :—

Oita	3h 43m 4s a.m.	Strong.	Houses damaged ; followed by minor shocks.
Kumamoto ..	3. 43. 29	,,	Motion quick, accompanied by vertical movements ; houses shaken.
Saga	3. 46. 12 (?)	,,	
Miyazaki ..	3. 43. 4	,,	Walls cracked ; followed by minor shocks.
Kagoshima ..	3. 43. 21	,,	Houses shaken.
Matsuyama ..	3. 42. 12 (?)	Weak.	
Nagasaki ..	3. 44. 33	,,	Motion quick ; houses shaken.
Osaka	3. 45. 17	,,	Duration long.
Fukuoka ..	3. 48. 50	,,	Accompanied by vertical motion.
Oshima	3. 41. 0	,,	Houses shaken.
Hiroshima ..	3. 42. 20	,,	
Iida	3. 49. 20 (?)	Slight.	
Kochi	3. 45. 38	,,	
Tokyo	3. 45. 41	,,	
Mito	3. 43. 20	,,	

Oita	3h 55m 7s a.m.	Strong.	Motion quick ; houses shaken.
Saga	3. 56. 18 (?)	,,	
Kumamoto ..	3. 54. 10	,,	Motion quick, accompanied by vertical movements.
Fukuoka ..	3. 50. 43	Weak.	Accompanied by vertical motion ; houses shaken.
Kagoshima ..	3. 55. 0	,,	Houses shaken.
Osaka	3. 56. 52	,,	Duration long.

Hiroshima	..	3h 54m 10s a.m.	Slight.	Accompanied by vertical motion.
Nagasaki	..	3. 55. 10	,,	Houses shaken.

The earthquake was recorded by the usual EW (*A*-machine) and the NS component (*B*-machine) pendulums as well as by the large long-period horizontal pendulum (*C*-machine). The diagram from the last-named of these three pendulums was taken very satisfactorily and shall therefore be first described.

(EW component; C machine).

The P.T., whose duration was 1m 42s, consisted of thirteen vibrations of an average period of 8,2s, the max. 2a being 0,5 mm. There were also some slight traces of very slow undulations.

The P.P. began with an abrupt displacement of 2,2 mm towards W. Then followed a large undulation (a) of period 35,4s, which consisted of the following two movements:

6,4 mm towards E,
6,5 mm ,, W.

During the next 1m 55s there were six undulations, giving an average period of 23s. These slow waves which together lasted for 3m were superposed with small quick vibrations, apparently continued from the P.T. From 3h 49m 53s, that is 4m 38s after the beginning of the earthquake, quicker waves became prominent; the motion consisting essentially of the following two types (1) and (2):—

(1) vibrations of an average period of 8,0s whose max. 2a of 2,7 mm occurred at about 3h 51m 15s.

(2) undulations of an average period of 17,0s, whose max. 2a (b) of 6,4 mm occurred at 3h 49m 25s; formimg the last but one wave of the P.P. or at 2m 28s after the commencement of the P.P.

The exact commencement of the 2nd earthquake was obscured by the E.P. of the first. The long period maximum undulation, however, began

to appear at 3h 58m 39m, that is 11m 42s after the occurrence of the corresponding wave in the first earthquake; the (max.) 2a (a′) being [illegible] mm and the period 31,3s. Then followed, six well defined waves of an average period of 23s; the slow undulations together lasting for 3m. The absolute max. motion (b′) (2a = 3,6 mm), whose period was 17,6s, occurred at 3h 15m 56s, or at 2m 32s after the commencement of the P.P. and was the last but one undulation of the P.P.

The two earthquakes were thus exactly similar to each other; there being in each case first a maximum undulation of a very slow period (a, a′), and subsequently another maximum wave (b, b′) whose period was about half of that of the first. The time intervals between a and b and between a′ and b′ were respectively 2m 3s and 2m 2s; while the time differences between a and a′ and between b and b′ were each 11m 35s.

In the E.P. of the 2nd earthquake the average period was 8,1s (measured from 80 vibrations).

(NS component).

The P.T. which lasted for 2m 6s and which began with a displacement of 0,1 mm towards S, consisted at first of small vibrations (max. 2a = 1,3 mm) of an average period of 8,2s. At 49s from the commencement there appeared two well pronounced undulations of an average period of 23,5s; this was followed by a third vibration of a period of 33,3s.

The P.P. began with an abrupt motion of 1,8 mm towards S, its counter motion being 5,2 mm towards N. This was followed by two undulations of an average period of 25s, whose max. 2a was 9,6 mm. After this, strong pendulum oscillations set in, the pointer having been thrown out of the record-receiver. At 5m 30s from the beginning of the earthquake, the pointer came of itself again on the latter and thereafter record was taken till the end of the motion.

The beginning of the second earthquake was obscured by the proper pendulum oscillations in the E.P. of the first earthquake. The maximum pendulum motion, however, occurred at 4h 0m 45s, that is at about 12m after the corresponding movement in the first earthquake. The active pendulum oscillations ceased at about 4h 8½m.

The E.P. The average period, deduced from two groups of 60 vibrations, taken at about 4h 33m, was as follows:—

10,6s		(General mean)
10,5		10,6s.

(EW component).

The P.T., which began with a motion of 0,2 mm towards W, consisted at first of vibrations of an average period of 8,3s. At 36s from the commencement three pendulum oscillations took place.

At 1m 48s from the commencement there appeared a large undulation (probably mixed in part with the pendulum oscillation) whose 2a was 7,9 mm and whose period was 32,5s. The next movement was still larger and the pointer was driven out of the record-receiver. After 23m the pointer came back of itself again on the record-receiver.

GROUP VII.—*Earthquakes which originated in Central Japan.*

Eqke No. 9. August 1st 1898; 2h 12m 21s p.m.
Total duration = 6m 15s.

Observations at Meteorological Observatories:—

Tsu	2h 7m 20s p.m.	Strong.	Motion gentle.
Nagoya	2. 11. 58	Weak.	Motion quick, accompanied by vertical movements.
Hikone	2. 15. 00	„	Houses shaken.
Gifu	2. 11. 39	Slight.	Accompanied by sound.
Fukui	2. 12. 00	„	Doors shaken.
Kyoto	2. 12. 18	„	
Osaka	2. 12. 11	„	Motion gentle.
Mito	2. 13. 51		
Wakayama ..	2. 14. 00		
Kofu	2. 14. 05		
Yagi	2. 18. 00		
Tokyo	2. 24. 18		

(NS component).

The P.T., whose duration was 58s, consisted of small quick vibrations.

The P.P., whose duration was 1m 20s, began with well defined vibrations of an average period of 2,1s, superposed on slower ones of an average period of about 6,5s. The max. 2a of 0,05 mm occurred at the commencement.

(EW component).

The P.T. lasted for 49s.

The P.T., whose duration was 1m 30s, consisted of vibrations of an average period of 8,7s, superposed of an average period of 5,2s. The r. 2a was 0,09 mm.

Eqke No. 56. November 13th 1898; 11h 33m 3s a.m.
Total duration = 13m.

Observations at Meteorological Observatories:—

Nagoya	11h 32m 16s a.m.	Strong.	Motion quick, accompanied by vertical movements: houses shaken.
Gifu	11. 31. 33	,,	Accompanied by vertical motion; liquids overflowed.
Tsu	11. 34. 35	,,	Houses shaken.
Hikone	11. 35. 10	,,	Pendulum clocks stopped.
Kofu	11. 31. 33	Weak.	Accompanied by vertical motion; houses shaken.
Hamamatsu ..	11. 31. 40	,,	Motion gentle.
Yagi	11. 32. 9	,,	Accompanied by vertical motion; houses shaken.
Iida	11. 32. 15	,,	,, ,,
Numazu ..	11. 32. 32	,,	Motion quick; accompanied by vertical movements; articles fell from shelves.
Kyoto	11. 32. 35	,,	
Osaka	11. 33. 25	,,	Houses shaken.
Kobe	11. 29. 30	Slight.	Motion quick.
Fukui	11. 29. 33	,,	Duration long.
Yokohama ..	11. 31. 58	,,	Motion gentle.
Okayama ..	11. 32. 0	,,	
Kumagae ..	11. 32. 56	,,	Doors shaken.
Maebashi ..	11. 33. 0	,,	Motion gentle.
Tokyo	11. 33. 12	,,	

Mito	11h 33m 32s a.m.	Slight.	
Tadotsu	11. 33. 46	,,	Motion gentle.
Utsunomiya ..	11. 33. 47	,,	
Matsuyama ..	11. 35. 11	,,	
Matsumoto ..	11. 35. 20	,,	

The P.T., whose duration was 29s, consisted of very small vibrations of an average period of 2,2s, superposed with still quicker ones.

The P.P., whose duration was 1m 30s, consisted at first of small quick vibrations of an average period of about 1,1s, the initial displacement being 0,1 mm towards E and 0,05 mm towards N. After 1m 15s there appeared 7 well defined slower vibrations, which lasted 52,4s and had an average period of 7,5s; the first of the group having the max. (abs.) 2a of 0,46 mm in the EW and 0,50 mm in the NS component. The waves in the succeeding portion had a slightly shorter period.

The E.P. The average period was 6,6s.

Eqke No. 81. January 22nd 1899; 8h 4m 3s a.m.

Total duration = 13m.

Observations at Meteorological Observatories:—

Nagano ..	8h 4m 18s a.m.	Strong.	Houses shaken.
Nagoya ..	7. 58. 56	Weak.	Accompanied by vertical motion.
Kyoto ..	8. 4. 16	,,	
Hikone ..	8. 4. 52	,,	Accompanied by vertical motion.
Iida	8. 5. 10	,,	Houses shaken.
Hamamatsu.	8. 5. 30	,,	Motion quick.
Maebashi ..	8. 7. 7	,,	Motion gentle.
Tsu	8. 8. 50	,,	
Matsumoto .	8. 9. 49	,,	Motion quick; accompanied by vertical motion.
Osaka ..	8. 4. 38	Slight.	Motion gentle.

Yokosuka	8h 4m 47s a.m.	Slight.	
Mito .. .	8. 4. 50	„	Motion gentle.
Numazu .	8. 4. 55	„	Motion quick.
Tokyo .. .	8. 4. 59	„	
Utsunomiya .	8. 5. 0	„	Motion gentle.
Kumagae .	8. 5. 10	„	
Fukui .. .	8. 5. 30	„	Duration long.
Tadotsu .	8. 6. 7	„	Motion gentle.
Yagi .. .	8. 10. 40	..	

The P.T., whose duration was 27s, consisted of quick vibrations of an average period of 0,84s, superposed on slight traces of slower waves of an average period of 6,5s. The max. 2a was 0,14 mm in the EW and 0,1 mm in the NS component.

The P.P., whose duration was 4½m, was especially active during the first 1¾m. The motion consisted of small quick vibrations superposed on waves of an average period of 2,3s, whose max. 2a was 0,55 mm in the EW and 0,5 mm in the NS component. These latter vibrations were in their turn superposed on slow undulations of an average period of 11,7s, whose max. 2a was 0,55 mm in the EW and 0,6 mm in the NS component. Towards the end, the average period was 6,9s.

The E.P. The average period was 8,0s.

P.O. There existed minute P.O. on the 21st and on the early morning of the 22nd. These however almost disappeared before the occurrence of the earthquake. The average period was as follows:—

3,9s (on the 21st, after-noon);

4,2 (immediately before the earthquake).

Eqk No. 87. February 6th 1899; 4h 7m 54s a.m.

Total duration=8m.

Observations at Meteorological Observatories:—

.. ..	4h 7m 49s a.m.	Slight.	
Gifu.	4. 8. 18	„	Motion quick; accompanied by vertical motion.

Nagoya	4h 8m 25s a.m	Slight.	Accompanied by vertical motion.
Yokohama ..	4. 8. 38	„	
Fukui	4. 8. 50	„	
Tokyo	4. 9. 0	„	
Hikone	4. 9. 15	„	Duration long.
Kyoto	4. 9. 35	„	
Iida	4. 10. 15	„	Accompanied by vertical motion.
Nagano	4. 10. 50	„	
Matsumoto ..	4. 22. 35 (?)	„	

The P.T., whose duration was 24s, consisted of small quick vibrations.

The P.P., whose duration was 2m 3s, began with a motion of 0,1 mm in the EW and 0,02 mm in the NS component. For the first 12s the motion remained small and consisted of quick vibrations. Then followed slower waves of an average period of 7,9s, whose max. 2a was 0,15 mm in the EW and 0,10 mm in the NS component.

The E.P. The principal vibrations had an average period of 6,4s, there being also traces of others of an average period of 3,3s.

P.O. There were slight P.O. The max. 2a was 0,03 mm in each component and the average period, measured 2hs before the earthquake, was 4,5s.

Eqke No. 233. November 21st 1899; 6h 56m 29s p.m.
Total duration = 20m.

Observations at Meteorological Observatories :—

Takayama ..	6h 56m 9s p.m.	Weak.	Houses shaken.
Fukushima ..	6. 56. 40	„	Motion quick; doors shaken.
Maebashi ..	6. 57. 25	„	Motion gentle.

Matsumoto ..	6h 58m 30s p.m.	Weak.	Accompanied by vertical motion ; houses shaken.
Iida	6. 59. 55	„	Motion gentle.
Fukushima ..	6. 52. 22	Slight.	
Kofu .. .	6. 55. 45	„	Houses shaken.
Kyoto ..	6. 56. 8	„	
Gifu..	6. 56. 22,	„	Duration long.
Nagoya	6. 56. 23	„	Motion gentle.
Nagano .. .	6. 56. 23	„	Houses shaken.
Fukui	6. 56. 37	„	Duration long.
Hikone	6. 56. 40	„	Motion quick ; accompanied by vertical motion.
Tokyo	6. 56. 49	„	
Numazu	6. 57. 4	„	Motion gentle.
Kanazawa ..	6. 57. 30	„	
Mito..	6. 57. 32	„	
Kumagae.. ..	6. 57. 37	„	
Yokohama ..	6. 57. 59	„	Motion quick.

(NS component).

The P.T. consisted of small vibrations of an average period of 2,1s, superposed on slower ones of an average period of 5,8s.

The P.P., whose duration was 2m 40s, began with a few vibrations (max. 2a=0,3 mm) whose average period was 2s. 1m 6s later there appeared 4 nearly equal well defined waves (max. [abs.] 2a=0,8 mm) of an average period of 6,8s, which together lasted 27,3s. In the remaining portion of this epoch the average period was 4,5s.

The E.P. In the earlier portion, the motion consisted of small vibrations of an average period of 3,3s, superposed on others of an average period of 7,9s. Towards the end the average period was 6,3s.

(EW component).

The P.T., whose duration was 28s, consisted of small vibrations of an average period of 2,8s, superposed on slower ones of an average period of 9,3s.

The P.P., whose duration was 4m 30s, consisted for the first 16s of quick vibrations (max. 2a = 0,55 mm) of an average period of 2,7s. Then there appeared two slow undulations (2a = 0,55 mm) of an average period of 10s. These were followed by vibrations of an average period of 4,6s; the first of the group having the max. (abs.) 2a of 1,0 mm. Towards the end the average period was 5,3s.

P.O. There existed slight P.O. The max. 2a was 0,05 mm in each component, and the average period was 3,9s.

GROUP VIII (a).—*Local Earthquakes observed at several places.*

**Eqke No. 1.* July 14th 1898; 7h 8m 59s p.m.
Total duration = 2½m.

Observations at Meteorological Observatories:—

Utsunomiya ..	7h 8m 50s p.m.	Weak.	
Maebashi	7. 8. 58	Slight.	
Mito	7. 8. 33	„	Motion quick.
Kofu	7. 8. 35	„	
Tokyo	7. 8. 50	„	
Yokosuka	7. 9. 0	„	
Kumagae	7. 9. 50	„	

The P.T. lasted for 8s.

The P.P. lasted for 20s. The max. 2a, which occurred at 4,3s from the commencement of this epoch, was 0,15 mm in each component.

The E.P. The average period was 1,9s.

Eqke No. 7. July 25th 1898; 0h 17m 4s p.m.
Total duration = 11m.

Observations at Meteorological Observatories:—

Yokosuka ..	0h 17m 12s p.m.	Weak.	Motion quick.
Tokyo	0. 17. 13	„	„
Yokohama ..	0. 17. 47	„	Accompanied by vertical motion.
Kofu	0. 17. 21	„	Houses shaken.
Mito	0. 17. 22	Slight.	Motion gentle.
Numazu	0. 17. 33	„	„
Maebashi ..	0. 17. 41	„	„

Utsunomiya ..	0h 17m 58s p.m.	Slight	Motion quick.
Fukui	0. 18. 5	„	
Fukushima ..	0. 19. 25	„	
Kumagae ..	0. 19. 40 (?)	„	

(EW component).

The P.T., whose duration was 11,0s, consisted of vibrations (max. 2a =0,2 mm) of an average period of 1,4s, superposed with still quicker movements. The very first displacement was directed towards W. The amplitude remained nearly constant.

The P.P. lasted for 57s, the motion being especially active for the first 23s. The initial displacement was 1 mm and directed towards W, the counter movement (max.) being 1,4 mm towards E. The motion consisted essentially of waves of an average period of 1,2s, superposed with still quicker ones.

The E.P. The motion consisted of vibrations of an average period of 1,8s, superposed more or less definitely on slower ones of an average period of 4,9s. These waves were well defined and not confused by the traces of the P.O. which existed to a very slight amount.

P.O. The average period was as follows:—

4,7s (before the earthquake);
4,9 (after „ „).

mean......4,8s.

The NS component diagram was unfortunately rubbed off by mistake before varnishing it.

Eqke No. 8. July 27th 1898; 2h 35m 2s a.m.
Total duration=10m.

Observations at Meteorological Observatories:—

Mito	2h 35m 18s a.m.	Weak.	Houses shaken.
Utsunomiya ..	2. 35. 20	„	Motion gentle.

[illegible]	2h 35m 3s a.m.	Slight.	Houses shaken.
Maebashi	2. 35. 7	"	Motion gentle.
Choshi	2. 35. 30	"	
Tokyo	2. 35. 31	"	

(NS component).

The P.T., whose duration was 17s, consisted of vibrations of an average period of 0,91s.

The P.P. consisted of very small vibrations of an average period of 1,0s, superposed on others of an average period of about 2,4s. There were also traces of waves of an average period of about 12s. The max. 2a was 0,07 mm.

The E.P. The average period was 3,4s.

(EW component).

The max. 2a was 0,09 mm.

Eqke No. 10. August 7th 1899; 11h 2m 56s p.m.

Total duration = 3m.

Observations at Meteorological Observatories :—

Mito	11h 3m 30s p.m.	Slight.	Motion quick.
Kumagae	11. 3. 40	"	
Tokyo	11. 3. 45	"	
Yokosuka	11. 3. 57	"	

The P.T., whose duration was 14s, consisted of very quick small vibrations. The amplitude gradually increased towards the end.

The P.P., whose duration was 25s, began with a well defined motion of 0,1 mm towards E and 0,05 mm towards S, followed by the counter displacement of 0,1 mm towards W and 0,08 mm towards N. The motion consisted of quick vibrations, superposed on waves of an average period of about 1,4s, whose max. 2a was 0,2 mm in the EW and 0,15 mm in the NS component.

The E.P. The average period was about 1,2s.

Eqke No. 13. August 11th 1898; 5h 40m 39s p.m.

This was a small local shock.

Observations at Meteorological Observatories :—

Kumagae ..	5h 40m 46s p.m.	Weak.	Motion quick, accompanied by vertical vibrations.
Tokyo ..	5. 40. 47	,,	Motion quick.
Yokohama .	5. 40. 50	,,	Accompanied by vertical motion.
Kofu .. .	5. 40. 30	,,	Houses shaken.
Mito	5. 40. 52	,,	
Yokosuka ..	5. 40. 57	,,	
Utsunomiya .	5. 41. 42	,,	Motion quick.
Choshi ..	5. 40. 30	Slight.	
Maebashi ..	5. 40. 45	,,	Motion gentle.
Fukui. ..	5. 41. 0	,,	
Numazu ..	5. 41. 25	,,	Duration short.

Eqke No. 25. September 4th 1898; 3h 53m 21s p.m.
Total duration = 1m 45s.

Observations at Meteorological Observatories :—

Mito	3h 52m 50s p.m.	Slight.	Motion quick.
Tokyo	3. 53. 5	,,	
Kumagae	3. 53. 9	,,	

This was a very small earthquake. The duration of the P.T. was about 4s.

Eqke No. 26. September 5th 1898; 4h 47m 35s p.m.
Total duration = 1m 30s.

Observations at Meteorological Observatories :—

Maebashi ..	4h 51m 28s p.m.	Strong.	Motion quick, accompanied by vertical movements; houses shaken.
Kumagae ..	4. 47. 12	Slight.	

Mito	.. ..	4h 47m 25s p.m.	Slight.	Motion quick.
Tokyo	.. ..	4. 47. 27	,,	
Kofu	.. ..	4. 47. 30	,,	Motion quick; followed by after-shocks.
Utsunomiya	..	4. 47. 49	,,	Motion quick.

The earthquake took place amidst a great storm of P.O. The commencement and the P.T. were, however, well defined.

The P.T. whose duration was 7s, consisted of very small quick vibrations.

The P.P. began with the max. 2a of 0,06 mm in the NS and 0,13 mm in the EW component. The rest of the motion was much smaller. The prevailing average period was about 0,8s.

Eqke No. 27. September 7th 1898; 1h 6m 38s p.m.
Total duration = 48s.

Observations at Meteorological Observatories:—

Tokyo	.. .. ..	1h 6m 42s p.m.	Slight.
Kumagae	.. ..	1. 7. 25	,,
Kofu	.. .. ..	1. 7. 50	,,
Yokosuka	.. ..	1. 6. 45	Weak.

This was a very small shock, the diagram showing merely traces of minute quick vibrations.

Eqke No. 38. September 28th 1898; 1h 40m 49s a.m.
Total duration = 10m.

Observations at Meteorological Observatories:—

Maebashi	..	1h 42m 51s a.m.	Weak.	Accompanied by vertical motion.
Utsunomiya	..	1. 43. 0		Motion quick, houses shaken.
Kumagae	..	1. 57. 15 (?)		Motion quick.

Yokosuka ..	1h 42m 55s a.m.	Weak.	Duration long.
Tokyo	1. 43. 2	„	Motion gentle.
Mito	1. 43. 9	„	Motion quick.
Mera	1. 44. 20	„	Doors shaken.
Kofu	1. 44. 10	Slight.	Accompanied by vertical motion.
Yokohama ..	1. 52. 0 (?)	„	

The P.T., whose duration was 9,1s, consisted of small vibrations of an average period of about 2,0s, superposed with others still quicker. The initial motion was directed towards SW.—The amplitude was at first small and became full-sized from about the middle of the epoch; the max. 2a was 0,1 mm in the EW and 0,05 mm in the NS component.

The P.P. whose duration was 1m 27s, was most active during the first 47s. It began with a motion of 0,8 mm towards E and 0,6 mm towards S, followed by a counter (max.) displacement of 0,9 mm towards W and 1,1 mm towards N. The prevailing average period was 0,63s, there being also some traces of vibrations of about 2s period.

The E.P. The motion consisted essentially of vibrations of an average period of 2,8s, superposed on others of an average period of 4,5s. Towards the very end, the average period was 5,0s.

Eqke No. 41. October 6th 1898; 4h 52m 22s a.m.
Total duration=1m 15s.

Observations at Meteorological Observatories :—

Utsunomiya	4h 52m 30s a.m.	Slight.	Motion gentle.
Mito	4. 53. 16	„	Motion quick.
Tokyo	4. 55. 59	„	

The P.T. lasted for about 6s.

The P.P. The max. 2a, which occurred at the commencement, was very small.

The E.P. There were some traces of undulations of an average period of about 15s.

Eqke No. 46. October 20th 1898; 3h 15m 46s p.m.

Total duration = 1m 14s.

Observations at Meteorological Observatories:—

Kofu	3h 15m 10s p.m.	Slight.
Tokyo	3. 16. 2	,,
Yokohama..	3.. 16. 15	,,
Utsunomiya	3. 16. 24	,,

The P.T., whose duration was 7,7s, consisted of very small quick vibrations of an average period of about 0,5s.

The P.P., whose duration was 15s, consisted of vibrations of an average period of 0,49s. The initial displacement was directed towards SW, and the max. 2a was 0,02 mm in each component.

The E.P. The average period was about 0,6s.

In the EW component there was, at 36s from the commencement of the earthquake, a second slight but decided increase of the amplitude.

Eqke No. 49. October 26th 1898; 10h 30m 14s a.m.

Total duration = 2m 44s.

Observations at Meteorological Observatories:—

Choshi	10h 27m 6s a.m.	Slight.
Yokohama	10. 30. 32	,,
Tokyo	10. 30. 47	,,
Kofu..	10. 31. 20	,,
Utsunomiya	10. 36. 32	,,
Mito	10. 29. 50	,,

The P.T. lasted for 16s.

The P.P. began with the max. 2a of 0,07 mm towards W and 0,05 mm towards S. The end was somewhat confused by P.O.

Eqke No. 54. November 12th 1898; 2h 42m 40s a.m.

Total duration = 2m.

Observations at Meteorological Observatories:—

Choshi	2h 25m 23s a.m.	Slight.	
Ishinomaki	2. 37. 10	„	
Utsunomiya	2. 42. 20	„	
Mito	2. 42. 58	„	Motion gentle.
Yokosuka	2. 43. 10	„	
Tokyo	2. 46. 38	..	

The P.T. lasted for 9s.

The P.P., whose duration was 19s, consisted of small quick vibrations superposed on others of an average period of about 1,1s. The max. 2a was 0,14 mm in the EW and 0,05 mm in the NS component.

The E.P. The average period was about 1,5s.

The end was confused by P.O.

Eqke No. 55. November 12th 1898; 9h 42m 25s a.m.

Total duration = 12m.

Observations at Meteorological Observatories:—

Tokyo	9h 42m 19s a.m.	Weak.	Motion quick.
Yokosuka ..	9. 42. 22	„	Duration short.
Kofu	9. 42. 35	„	Accompanied by vertical motion; houses shaken.
Maebashi ..	9. 42. 45	Slight.	Motion gentle.
Mito	9. 42. 27	„	Motion quick.
Utsunomiya ..	9. 43. 8	„	Motion gentle.
Nagoya	9. 43. 15	„	
Fukushima ..	9. 43. 50	„	
Choshi	9. 44. 0	„	Motion quick.
Matsumoto ..	9. 44. 19	„	

(NS component).

The P.T., whose duration was 10s, consisted of quick small vivrations, superposed more or less distinctly on 4 slower waves (max. 2a = 0,15 mm) of an average period of 2,1s.

The P.P., whose duration was 34s, began with the max. 2a of 1,2 mm towards N. The motion was composed of very quick vibrations which continued till 67s after the commencement of the earthquake, and which were superposed on traces of waves of an average period of about 2,8s.

The E.P. The motion consisted essentially of vibrations of an average period of 2,3s, superposed on slower ones of an average period of 7s.

The EW component diagram was lost, as the earthquake took place while the record-receiver was being changed.

Eqke No. 55. November 20th 1898; 3h 42m 4s a.m.

Total duration = 1m 30s.

Observations at Meteorological Observatories:—

Tokyo	3h 41m 12s a.m.	Slight.	
Kumagae	3. 41. 24	„	
Mito	3. 42. 3	„	Motion quick.
Utsunomiya	3. 42. 40	„	
Kofu	3. 47. 13	„	

The P.T., whose duration was 6s, consisted of very small quick vibrations of an average period of about 0,4s.

The P.P., whose duration was 6,5s, consisted of quick vibrations. The initial displacement was directed towards SW, and the counter displacement (max.) was 0,10 mm towards E and 0,07 mm towards N.

The E.P. The prevailing average period was 1,0s.

The motion was somewhat confused by P.O.

Eqke No. 62. November 28th 1898; 7h 2m 34s a.m.

Total duration = 2m 10s.

Observations at Meteorological Observatories:—

Tokyo	7h 2m 47s a.m.	Slight.	
Maebashi . ..	7. 3. 39	„	Motion gentle.

Mito	7h 3m 54s a.m.	Slight.	Motion quick.
Utsunomiya	7. 4. 0		
Kumagae	7. 3. 20		

(NS component).

The P.T., whose duration was 8,8s, consisted of vibrations of an average period of 6,8s, superposed with quicker ones.

The P.P., whose duration was 30s, began with the max. 2a of 0,1 mm. The motion was superposed with quick vibrations.

The E.P. The motion consisted of small vibrations of an average period of 1,1s, superposed on others of an average period of 4,8s.

P.O. There were slight P.O. Their average period was as follows:—

4,8s (1h before the earthquake);
4,9 (1h after „ „).

Eqke No. 67. December 5th 1898; 0h 47m 53s a.m.
Total duration = 3m.

Observations at Meteorological Observatories:—

Choshi	0h 50m 23s a.m.	Slight.
Tokyo	0. 50. 33	
Utsunomiya	0. 50. 30	
Kumagae	0. 50. 30	
Mito	0. 51. 0	

The P.T. and the P.P. consisted of quick vibrations.

The P.T. lasted for 7s.

The P.P. lasted for 26s. The first displacement was 0,15 mm towards E and 0,1 mm towards S, and the counter motion (max.) was 0,2 mm towards W and 0,22 mm towards N.

The end was confused by P.O.

P.O. The max. 2a was 0,03 mm in each component, and the average period, measured immediately before the earthquake, was 4,2s,

Eqke No. 73. December 25th 1898; about 1h a.m.

Total duration = 3m.

Observations at Meteorological Observatories :—

Tokyo	1h 1m 46s a.m.	Slight.	
Mito	1. 1. 48	„	Motion gentle.
Matsumoto	1. 2. 40	„	
Utsunomiya	1. 3. 0	„	Motion gentle.
Fukushima	1. 5. 3	„	

(NS component).

The P.T., whose duration was 10s, consisted of very small quick vibrations of an average period of 1s.

The P.P. lasted for 35s. The max. 2a was 0,04 mm.

The end was confused by small P.O. The EW component diagram was not obtained as the writing index had been, through an accident, previously uplifted off the smoked paper.

Eqke No. 77. January 1st 1899; 1h 49m 45s a.m.

Total duration = 2m 30s.

Observations at Meteorological Observatories :—

Tokyo	1h 51m 1s a.m.	Slight.	
Yokosuka	1. 51. 15	„	
Mito	1. 51. 51	„	Motion quick.
Matsumoto	1. 54. 37	„	

The commencement was not clear, on account of the presence of slight P.O. The duration of the P.T. was, however, about 7s.

The P.P., whose duration was 20s, consisted of quick vibrations. It began with a well defined motion of 0,12 mm towards E and 0,07 mm towards S, followed by the counter displacement (max.) of 0,14 mm towards W and 0,07 mm towards N.

Eqke No. 80. January 14th 1898; 11h 30m 42s a.m.

Total duration = 30s.

Observations at Meteorological Observatories :-

Utsunomiya	11h 30m 10s a.m.	Slight.	Motion gentle
Tokyo	11. 30. 35	,,	
Kumagae	11. 30. 38	,,	

The P.T. was obscured by a very powerful storm of P.O.

The P.P. began with a well defined motion towards SE, the counter displacement (max.) being 0,1 mm towards W and 0,14 mm towards N.

P.O. The max. 2a was 0,1 mm in each component and the average period was 4,8s.

Eqke No. 83. January 23rd 1899; 2h 55m 38s p.m.

Total duration = 40s.

Observations at Meteorological Observatories :—

Mito .. .	2h 52m 40s p.m.	Weak.	Motion quick; houses shaken.
Tokyo .. .	2. 51. 38	Slight.	
Maebashi .	2. 52. 36		
Kumagae .	2. 52. 40		
Utsunomiya	2. 52. 42		Motion quick.
Choshi	2. 52. 30		

The P.T. was obscure.

The P.P. began with the max. 2a of 0,05 mm in the EW and 0,07 mm in the NS component. In the former component there was a second max. 2a of 0,04 mm at 6½s after the first maximum.

Eqke No. 96. March 6th 1899; 8h 11m 40s p.m.

Total duration = 6m.

Observations at Meteorological Observatories :—

Choshi	8h 10m 0s p.m.	Slight.	
Tokyo	8. 11. 47		
Mito	8. 11. 55		Motion quick.

Utsunomiya	8h 12m 2s p.m.	Slight.	Motion gentle.
Fukushima	8. 12. 11		

(EW component).

The P.T. lasted for 11s.

The P.P. consisted of small quick vibrations of an average period of 1,1s. The max. 2a was 0,04 mm.

The E.P. The average period was 2,2s.

The motion was confused somewhat by slight P.O.

The EW component diagram was obscured by the superposition of several lines.

Eqke No. 104. March 16th 1899; about 8h 54m a.m.

Observations at Meteorological Observatories :—

Kumagae	8h 54m 11s p.m.	Slight.
Tokyo	8. 54. 25	,,
Kofu	8. 55. 45	,,

This was an extremely small local shock, the diagram showing merely traces of small quick vibrations confused by P.O.

P.O. There existed a strong storm of P.O., whose max. 2a was 0,06 mm in each component. The average period was as follows :—

5,3s (on the 17th, morning),
4,0 (on the 16th, after-noon).

Eqke No. 114. March 24th 1899; 6h 39m 40s p.m.

Total duration $=4\frac{1}{2}$m.

Observations at Meteorological Observatories :—

Mito	6h 39m 20s p.m.	Slight.
Kumagae	6. 38. 59	,,
Utsunomiya	6. 39. 26	,,
Maebashi	6. 39. 49	,,
Tokyo	6. 39. 52	,,

Yokohama	6h 39m 59s p.m.	Slight.
Fukushima	6. 40. 0	„
Kofu	6. 40. 26	„

The P.T. lasted for 9s.

The P.P. began with the max. 2a of 0,15 mm towards W (?) and 0,2 mm towards N. The motion consisted of vibrations of an average period of about 2,4s, superposed with quick smaller vibrations. The latter continued to appear for altogether 1m 10s.

P.O. Small P.O. began to appear from about 2 hours before the earthquake. The max. 2a was 0,07 mm in each component and the average period was 4,3s.

Eqke No. 117. April 2nd 1899; 11h 1m 5s p.m.

Total duration = 4m.

Observations at Meteorological Observatories:—

Kofu	11h 18m 50s p.m.	Slight.
Tokyo	11. 19. 27	„
Mito	11. 19. 31	„

(EW component).

The P.T. whose duration was 5½s consisted of very small and quick vibrations.

The P.P., whose duration was about 9s, began with the max. 2a of 0,1 mm. 7,8s later on there occurred a second max. 2a of 0,06 mm. The motion consisted of very quick vibrations.

There existed slight traces of quick P.O.

(NS component).

The max. 2a was 0,06 mm. In this component there was no second maximum motion.

Eqke No. 118. April 5th 1899; 1h 0m 53s p.m.

Total duration = 9m.

Observations at Meteorological Observatories:—

Kofu	0h 59m 42s p.m.	Weak.	Motion quick; accompanied by vertical movements; houses shaken.
Yokohama	1. 0. 44	„	Motion quick, accompanied by vertical movements.
Mera	1. 1. 0	„	Doors shaken.
Tokyo	1. 1. 18	„	Motion quick.
Yagi	0. 57. 43	Slight.	
Kumagae ..	1. 0. 59	„	
Utsunomiya ..	1. 1. 11	„	
Mito	1. 1. 22	„	Motion quick.
Fukui	1. 1. 27	„	
Numazu	1. 0. 40	Weak.	Motion quick; accompanied by vertical movements.
Yokosuka ..	1. 0. 42	„	
Matsumoto ..	0. 59. 8	Slight.	
Fukushima ..	0. 59. 20	„	
Nagano	1. 1. 29	„	
Nagoya	1. 1. 38	„	
Tsu..	1. 1. 38	„	
Gifu	1. 1. 40	„	
Choshi	1. 1. 54	„	
Maebashi ..	1. 4. 9	„	

The P.T. lasted 20s.

The P.P., whose duration was 1m 33s, consisted of sharp quick vibrations, superposed with traces of slower waves of an average period of about 2,1s. The max. 2a was 0,8 mm in the EW and 0,9 mm in the NS component. The small quick vibrations disappeared at about 1m 22s from the commencement of the earthquake, and then waves of an average period of 3,2s became prominent.

Eqke No. 124. April 15th, 1899; 7h 25m 30s p.m.

Total duration = 33m.

Observations at Meteorological Observatories :—

Kumagae ..	7h 25m 56s p.m.	Strong.	Houses shaken.
Maebashi ..	7. 25. 53	„	Accompanied by sound; houses shaken.
Mito	7. 24. 35	Weak.	Motion quick; accompanied by vertical movements; houses shaken.
Kofu	7. 25. 15	„	
Utsunomiya ..	7. 25. 52	„	Motion quick; accompanied by vertical movements.
Tokyo	7. 25. 54	„	Duration long.
Yokosuka ..	7. 26. 3	„	„
Yokohama ..	7. 26. 4	„	„
Fukushima ..	7. 26. 51	„	Motion quick; houses shaken.
Matsumoto ..	7. 29. 0	„	Motion gentle.
Choshi	7. 25. 22	Slight.	Accompanied by vertical movements.
Yagi	7. 25. 45	„	
Osaka	7. 26. 5	„	Motion gentle.
Numazu ..	7. 26. 13	„	„
Miyako	7. 26. 15	„	„
Tsu	7. 26. 19	„	Duration long.
Nagoya	7. 26. 39	„	Motion gentle.
Iida	7. 26. 45	„	„
Ishinomaki ..	7. 26. 50	„	Duration long.
Nagano ..	7. 26. 58	„	„
Sakai	7. 30. 18	„	

The P.T., whose duration was 12,8s, consisted of small quick vibrations, superposed on traces of waves of an average period of about 2s.

The P.P., whose duration was 7½m, began with an abrupt vibration (period=2,3s), consisting of the following two displacements :

(1st motion) $\begin{cases} \text{1,25 mm towards E;} \\ \text{0,45 mm} \quad ,, \quad \text{S.} \end{cases}$

(2nd motion) $\begin{cases} \text{1,3 mm} \quad ,, \quad \text{W;} \\ \text{1,05 mm} \quad ,, \quad \text{N.} \end{cases}$

Then followed a number of well defined waves of an average period of 5,5s, whose amplitude remained nearly constant for 2m 39s; the first vibration having the max. (abs.) 2a of 1,7 mm in the EW and 1,6 mm in the NS component. The six vibrations of the above group, which occurred from about 2m 12s after the commnecement were especially well defined and had an average period of 5,0s. Towards the end there were well defined vibrations of an average period of 2,9s, their max. 2a being 1,0 mm in the EW and 0,4 mm in the NS component. The max. 2a of the superposed quick vibrations, which were continued till 2m 34s after the commencement of the earthquake, was about 0,6 mm in each component.

The E.P. At first, the motion consisted of vibrations of an average period of 7,2s, superposed on others of an average period of 3,9s. Towards the end, the average period was 7,4s.

Eqke No. 131. April 24th 1899; 6h 36m 59s a.m.
Total duration=5m.

Observations at Meteorological Observatories :—

Yokosuka .. .	6h 38m 11s a.m.	Weak.	
Kofu	6. 36. 2	Slight.	
Fukushima .. .	6. 37. 40	,,	
Kumagae .. .	6. 38. 17	,,	
Tokyo	6. 38. 20	,,	
Mito	6. 38. 46	,,	Motion quick.

The 1st P.T., whose duration was 3,6s, consisted of very small quick vibrations of an average period of about 0,51s.

The 2nd P.T., whose duration was 6,7s, consisted also of quick vibrations; the max. 2a being 0,05 mm in each component.

The P.P., whose duration was 40s, began with the max. 2a of 0,2 mm in the EW and 0,05 mm in the NS component.

The E.P. Towards the end the average period was 1,4s. There existed probably vibrations of longer period, but these were obscured by small P.O.

P.O. The average period, measured 1h before the earthquake, was 3,6s.

Eqke No. 133. May 2nd 1899; 1h 2m 22s a.m.

Total duration = 6m.

Observations at Meteorological Observatories :—

Mera ..	1h 1m 5s a.m.	Weak.	Motion quick; houses shaken.
Yokosuka	1. 1. 40	,,	
Hikone ..	1. 0. 30	Slight.	Motion gentle.
Matsumoto	1. 0. 51	,,	
Tokyo ..	1. 1. 50	,,	Motion quick.
Kofu ..	1. 2. 5	,,	Motion gentle.
Mito ..	1. 2. 12	,,	Motion quick.
Utsunomiya	1. 3. 8	,,	
Yokohama	1. 54. 29 (?)	,,	Motion quick.

The P.T., whose duration was 13s, consisted of small quick vibrations.

The P.P. lasted for 14s. The max. 2a, which occurred at the commencement, was 0,15 mm in each component.

The E.P. The waves had an average period of 1,9s, superposed on others of an average period of 3,7s.

Eqke No. 134. May 4th 1899; 10h 27m 28s a.m.

Total duration = about 1m.

Observations at Meteorological Observatories :-

Fukushima ..	10h 27m 9s a.m.	Slight.	Houses shaken.
Mito	10. 28. 17	„	Motion quick.
Tokyo	10. 28. 42		

The P.T. and the P.P. consisted of very small quick vibrations.

The P.T. lasted for 5,8s.

The P.P. The max. 2a was 0,04 mm in the EW and 0,02 mm in the NS component.

The end was obscured by slight P.O.

P.O. The average period, measured immediately before the earthquake, was 3,6s.

Eqke No. 135. May 6th 1899; 2h 8m 34s p.m.
Total duration = 2m.

Observations at Meteorological Observatories :—

Tokyo	2h 9m 24s p.m.	Weak.	Motion quick.
Yokosuka	2. 9. 33	„	
Utsunomiya	2. 9. 0	Slight..	
Kofu	2. 9. 5	„	
Kumagae	2. 9. 15	„	
Yokohama	2. 9. 16	„	Motion quick.
Mito	2. 9. 20	„	„
Fukushima	2. 9. 30	„	

The P.T. lasted for 6s.

The P.P., whose duration was 20s, began with a motion of 0,35 mm towards E and 0,4 mm towards S, followed by the counter displacement (max.) of 0,45 mm towards W and 0,55 mm towards N. The rest of the motion was much smaller. The period of vibration was very short.

The E.P. The average period was 1.2s.

Eqke No. 157. July 7th 1899; 5h 12m 49s a.m.
Total duration = 5m.

Observations at Meteorological Observatories :—

Mito	5h 12m 25s a.m.	Slight.	
Tokyo	5. 12. 41	"	Motion quick.
Yokohama	5. 12. 49	"	

The P.T., whose duration was 9s, consisted of small vibrations of an average period of about 1,1s.

The P.P., whose duration was 20s, consisted of quick vibrations. The initial motion was 0,32 mm towards W and 0,25 mm towards, S, followed by the counter displacement (max.) of 0,42 mm towards E and 0,4 mm towards N.

The E.P. Towards the end the average period was 2,2s. The motion was somewhat confused by P.O.

Eqke No. 159. July 7th 1899; 6h 53m 17s a.m.
Total duration = 8m.

Observations at Meteorological Observatories :—

Choshi	6h 49m 57s a.m.	Slight.	
Mito	6. 51. 48	Weak.	Motion quick; accompanied by vertical movements; houses shaken.
Tokyo	6. 53. 5	"	Motion quick.
Yokohama ..	6. 53. 20	"	Motion quick; accompanied by vertical motion.
Utsunomiya ..	6. 54. 0	"	Motion quick; doors shaken.
Yokosuka ..	6. 51. 10	Slight.	Motion gentle.
Fukushima ..	6. 51. 50	"	
Mera	6. 51. 50	"	
Kofu	6. 52. 40	"	
Matsumoto ..	6. 53. 13	"	
Kumagae ..	6. 53. 15	"	
Maebashi ..	6. 53. 17	"	Motion gentle.

The 1st P.T. lasted for about 3s. The motion was very small.

The 2nd P.T., whose duration was 7,5s, began with a well defined displacement of 0,05 mm towards W and 0,04 mm towards S. The max. 2a was 0,15 mm in each component.

The P.P., whose duration was 1m 14s, consisted of quick vibrations. It began with a well defined displacement of 0.65 mm towards E and 0,35 mm towards N, the counter motion (max.) being 0,95 mm towards W and 0,7 mm towards S.

P.O. The average period, measured in the morning of the 6th, was 6,2s.

Eqke No 170. July 27th 1899; 2h 1m 5s p.m.

Total duration = 8m.

Observations at Meteorological Observatories :—

Utsunomiya	2h 1m 3s p.m.	Weak.	Motion quick.
Mito	2. 1. 5	„	Houses shaken.
Tokyo	2. 1. 5	Slight.	
Yokohama	2. 1. 6	„	Motion quick.
Kumagae	2. 1. 12	„	
Maebashi	2. 1. 15	„	Motion gentle.
Choshi	2. 2. 39	..	

The P.T. lasted for 9s. The motion was small.

The P.P., whose duration was 15s, consisted of quick vibrations. It began with the max. 2a of 0,24 mm in each component.

Eqke No. 179. August 7th 1899; 6h 11m 22s p.m.

Total duration = 5m.

Observations at Meteorological Observatories :—

Matsumoto	6h 0m 15s p.m.	Slight.	
Mito	6. 1. 21	„	Motion quick.
Tokyo	6. 1. 37		

Kumagae ..	6h 1m 39s p.m.	Slight.	Motion quick; accompanied by sound.
Yokohama ..	6. 1. 45	,,	
Utsunomiya ..	6. 3. 30	,,	Motion gentle.

The P.T., whose duration was 7s, consisted of small quick vibrations.

The P.P., whose duration was 30s, consisted of quick vibrations. The max. 2a of 0,22 mm in the EW and 0,2 mm in the NS component occurred at 4s after the commencement. In the NS component there were the second and third maximums which occurred respectively 5 and 10s after the first.

P.O. There existed slight traces of P.O., whose average period, measured immediately before the earthquake, was 5,1s.

Eqke No. 180. August 8th 1899; 9h 53m 41s p.m.
Total duration = 5m.

Observations at Meteorological Observatories:—

Mito	9h 53m 44s p.m.	Slight.	
Tokyo	9. 54. 3	,,	
Maebashi	9. 54. 3	,,	Motion quick.
Kumagae	9. 55. 0	,,	

The P.T., whose duration was 9s, consisted of small quick vibrations.

The P.P., whose duration was 20s, consisted of quick vibrations. The initial displacement was 0,1 mm towards E and 0,05 mm towards S, the counter motion (max.) being 0,15 mm towards W and 0,05 mm towards N.

P.O. There existed very slight traces of P.O.

Eqke No. 192. September 3rd 1899; 10h 7m 54s p.m.
Total duration = 5m.

Observations at Meteorological Observatories:—

Utsunomiya	10h 11m 30s p.m.	Weak.	Motion quick.
Mito	10. 9. 0	Slight.	Motion gentle.

Tokyo	10h 9m 3s p.m.	Slight.
Kumagae	10. 9. 27	„
Fukushima	10. 9. 40	„
Nagatsuro	10. 25. 51 (?)	„

The P.T., whose duration was 9,4s, consisted of very small quick vibrations.

The P.P., whose duration was 16s, consisted of quick vibrations. The amplitude remained nearly constant; the max. 2a being 0,12 mm in the EW and 0,07 mm in the NS component.

The end was confused by slight P.O.

P.O. The average period, measured immediately before the earthquake, was 4,4s.

Eqke No. 214. October 10th 1899; 6h 17m 54s a.m.

Total duration = 5m.

Observations at Meteorological Observatories:—

Yokosuka	6h 18m 0s a.m.	Weak.	Motion quick.
Utsunomiya	6. 18. 0	„	Motion gentle.
Yokohama	6. 17. 53	Slight.	
Kumagae	6. 18. 0	„	
Tokyo	6. 18. 2	„	
Mito	6. 18. 2	„	Liquids shaken.
Numazu	6. 18. 44	„	Motion quick.
Nagoya	6. 18. 45	„	
Choshi	6. 20. 0	„	
Matsumoto	6. 20. 13	„	

The P.T., whose duration was 10s, consisted of very quick vibrations. The max. 2a was 0,1 mm in the EW and 0,06 mm in the NS component.

The P.P., whose duration was 17s, began with the max. 2a of 0,22 mm in the EW and 0,16 mm in the NS component.

The E.P. was confused by P.O. In the earlier portion, however, there were some traces of vibrations of an average period of 1,8s.

GROUP VIII (b).—*Local Earthquakes observed in Tokyo and at one other place.*

Eqke No. 28. September 11th 1898; 10h 3m 32s p.m.

Total duration = 1m 7s.

Observations at Meteorological Observatories :—

Tokyo	10h 3m 35s p.m.	Slight.
Yokosuka	10. 3. 35	,,

This was a small earthquake at some distance. The P.T. lasted for 16s. (The beginning of motion was somewhat obscure).

The P.P. The max. 2a was 0,08 mm in the EW and 0,03 mm in the NS component.

Eqke No. 60. November 21st 1898; 9h 5m 53s a.m.

Total duration = ?

Observations at Meteorological Observatories :—

Tokyo	9h 7m 5s a.m.	Slight.
Kumagae	9. 7. 19	,,

This was a very small earthquake, the diagram showing merely slight traces of motion.

Eqke No. 72. December 19th 1898; 0h 0m 15s p.m.

Total duration = 1m 10s.

Observations at Meteorological Observatories :—

Mito	11h 59m 30s a.m.	Slight.	Motion quick, accompanied by vertical movements.
Tokyo	11. 59. 42		

This was a very small earthquake of a comparatively near origin.

The P.T. whose duration was 4s was well demarked and consisted of small and quick vibrations of an average period of 0,4s.

The P.P., whose duration was 14s, consisted of vibrations of an average period of 0,53s, there being no waves of longer period. The max. 2a was 0,08 mm in the EW and 0,04 mm in the NS component.

Eqke No. 79. January 8th 1899; 1h 11m 21s a.m.

Total duration = 2m 35s.

Observations at Meteorological Observatories :—

Tokyo	1h 16m 47s a.m.	Slight.
Utsunomiya	1. 12. 00	„

The was an extremely small earthquake.

P.T. lasted for 2,6s.

The P.P. The max. 2a was 0,02 mm in each component.

The E.P. The average period was 0,68s.

Eqke No. 121. April 11th 1899; 10h 5m 45s a.m.

Total duration = 1m.

Observations at Meteorological Observatories :-

Tokyo	10h 5m 58s a.m.	Slight.
Yokohama	10. 5. 55 „	„

(EW component).

The P.T., whose duration was 18s, consisted of very small and quick vibrations.

The P.P. lasted for 4,5s. The max. 2a of 0,16 mm (EW) occurred at the commencement.

The E.P. also consisted of very small and quick vibrations.

The record from the NS component pendulum was not obtained, as the earthquake happened while the drum of that machine was being changed.

Eqke No. 129. April 20th 1899; 5h 0m 31s p.m.
Total duration = 50s.

Observations at Meteorological Observatories :—

Tokyo	5h 10m 50s p.m.	Slight.
Fukushima	5. 10. 44	„

The P.T., whose duration was 9s, consisted of small and quick vibrations.

The P.P. The max. 2a, which occurred at the commencement was 0,16 mm in the EW and 0,08 mm in the NS component. The motion was active for about 3s, then there followed an interval of rest for about 1½s, when, in the EW component, there appeared a second max. 2a of 0.08 mm in the EW component. The motion was this time active for about 2s, so that the total duration of the P.P. was 8s.

The E.P. also consisted of small and quick vibrations.

Eqke No. 137. May 11th 1899; 5h 59m 12s a.m.
Total duration = 6m.

Observations at Meteorological Observatories :—

Yokohama	6h 1m 42s a.m.	Slight.
Tokyo	6. 1. 44	„

The P.T. lasted for 8,3s.

The P.P. which consisted entirely of small quick vibrations, began with the max. 2a of 0,05 mm in the EW and 0,01 mm in the NS component. The motion was active for the next 1½s. During the succeeding 3s the motion was small, when a second max. (abs.) 2a of 0,07 mm took place in the EW component, (very small, in the NS component). During the next 16s the motion was more or less active, there being occasional alternations of maximum and minimum groups.

The E.P. The average period was 7,2s.

Eqke No. 144. June 10th 1899; 10h 36m 56s p.m.
Total duration = 5m.

Observations at Meteorological Observatories ;—

Numazu	10h 36m 52s p.m.	Weak.	Motion quick.
Tōkyo	10. 36. 56	Slight.	

The P.T. lasted for 8,4s.

The P.P. began with a max. 2a of 0,05 mm in the EW and 0,02 mm in the NS component. In the latter component, the motion consisted, for the next 31s, of small and quick vibrations, superposed more or less distinctly on slow waves of an average period of 8,3s. This part may probably be taken as the 2nd P.T. After this the motion consisted principally of regular slow waves of an average period of 2,7s, of which the max. 2a of 0,07 mm occurred at 35s from the commencement of the P.P. In the EW component, the duration of the 2nd. P.T. was 22s, the motion following being characterized by the appearance of regular and larger vibrations of an average period of 3,2s. The max. 2a in this component was 0,06 mm, and occurred at 22s and also at 35s from the end of the (1st) P.T.

Eqke No. 191. September 2nd 1899; 3h 15m 45s a.m.

Total duration = 9m.

Observations at Meteorological Observatories :—

Tokyo	3h 16m 9s a.m.	Slight.
Matsumoto ..	3. 16. 27	,,

The beginning and end were somewhat obscured by P.O. In the earlier portion, the motion consisted of small vibrations of an average period of 1,7s. At about 3m 20s from the commencement, there appeared the P.P., whose average period was 5,3s, and whose max. 2a was 0,03 mm in the EW and 0,04 mm in the NS component.

P.O. The average period measured about 1h before the earthquake, was 3,6s.

Eqke No. 213. October 10th 1899; 1h 12m 43s a.m.

Total duration = about 8m.

Observations at Meteorological Observatories :—

Fukushima ..	1h 15m 54s a.m.	Slight.
Tokyo	(not observed.)	

This was a small earthquake at some distance. The beginning and end of the motion were rendered indistinct by the presence of slight P.O. P.T. was not well defined.

The motion began very gradually, and the P.P. consisted essentially of waves of an average period of 6s, superposed with small and quick vibrations. The max. 2a was 0,05 mm in the EW and 0,04 mm in the NS component.

The E.P. The average period was 5,1s.

GROUP VIII (c).—*Local Earthquakes observed only in Tokyo.*

Eqke No. 6. July 25th 1898; 6h 37m 57s a.m.

Total duration = 41s.

This was an extremely small local shock, having occurred while the eqke No. 5. was not yet completely ended.

The P.T. lasted for 4,9s in the NS and 6,7s in the EW component.

The P.P. consisted of waves of an average period of 9,4s, superposed on small quick vibrations. The max. 2a was 0,03 mm in the NS and 0,06 mm in the EW component.

Eqke No. 15. August 17th 1898; 4h 26m 50s p.m. (Cent. Met. Obs. 4h 16m 23s. Slight.)

Total duration = about 1m.

The P.T., whose duration was 6,6s, was well defined and consisted of small vibrations of an average period of 1,2s, superposed with others still smaller.

The P.P. began with a displacement of 0,05 mm towards E and 0,02 mm towards S, followed by a counter-motion (max.) of 0,12 mm towards W and 0,04 mm towards N.—The vibrations in the earlier portion had an average period of 1,5s, superposed with still smaller movements. There was no trace of waves of longer period.

Eqke No. 52. November 6th 1898; 9h 0m 50s a.m. (Cent. Met. Obs. 9h 2m 24s. Intensity, slight.)

Total duration = about 15m.

The origin of the earthquake was evidently at some distance, and the motion began very gradually.

The P.T. lasted for about 41,5s and consisted of very small vibrations

of an average period of 2,3s, superposed on very slight traces of others of longer period.

The P.P., whose duration was 2m 20s, consisted of vibrations of an average period of 4,8s. The maximum motion was 0,06 mm in the EW and also 0,06 mm in the NS component.

The E.P. The average period was 4,5s.

P.O. There were present very slight traces of P.O., whose average period was 4,9s.

Eqke No. 74. December 27th 1898; 4h 43m 42s p.m.
Total duration = 42s.

This was a very small local shock.

The P.T. lasted for 10s.

The P.P. consisted entirely of very small quick vibrations. In the EW component, the max. 2a of 0,08 mm occurred at about 2s from the commencement of this epoch, followed 2s later by a second max. 2a of 0,05 mm. In the NS component there were similarly two maximum movements, each equal to 0,03 mm.

P.O. There existed small quick P.O., whose max. 2a was 0,03 mm in each component; the average period being 4,0s.

Eqke No. 75. December 29th 1898; about 4h 12m a.m.
Total duration = about 3m.

This was a very small earthquake and the motion consisted of slight quick vibrations.

The P.T. lasted for about 20s.

The P.P. The max. 2a was 0,04 mm in the EW and 0,02 mm in the NS component.

The E.P. The principal average period was 2,5s.

Eqke No. 78. January 5th 1899; 9h 1m 3s a.m. (Cent. Met. Obs. 9h 1m 38s. Slight).
Total duration = 50s.

Slight P.O. existed throughout the day.

The P.T., whose duration was 9s, consisted of very small movements superposed on distinct slower ones of an average period of 4,8s.

The P.P. The maximum displacement, which occurred at the commencement of this stage, was 0,12 mm towards W and 0,15 mm towards N, the rest of the motion being very small. Motion was, however, more or less active during 7s. The well defined waves had an average period of 4,4s, superposed with much smaller ones.

Eqke No. 91. February 21st 1899; 1h 10m 5s a.m. (Cent. Met. Obs. 1h 10m 45s a.m. Slight).

Total duration = 4m 20s.

The P.T. lasted for about 2,3s.

The P.P. consisted of very small quick vibrations. The max. motion occurred at the commencement.

Eqke No. 101. March 13th 1899; 10h 51m 53s p.m. (Cent. Met. Obs. 10h 52m 1s. Slight).

Total duration = 30s.

There existed slight P.O., on whose account the end of the earthquake can not accurately be determined from the diagram. Immediately before the eqke, the average period of P.O. was 7,2s.

The P.T. lasted for 5,6s.

The P.P. lasted for 10s and began with a motion of 0,02 mm towards W and 0,01 mm towards S. In the EW component, a second (abs.) max. 2a of 0,05 mm occurred 2s later on, but in the NS component there was no corresponding maximum.

The motion consisted throughout of very small quick vibrations.

Eqke No. 116. March 29th 1899; 11h 42m 14s p.m. (Cent. Met. Obs. 11h 41m 32s. Slight).

Total duration = 3½m.

The origin of this earthquake was at some distance, and the motion showed no single well pronounced maximum.

The P.T. lasted 19s. The motion consisted of very small quick vibrations.

The P.P. The max. 2a was 0,04 mm in the EW and 0,01 mm in the NS component.

Towards the very end of the earthquake the average period was 4s.

Eqke No. 158. July 7th 1899; 6h 32m 16s a.m.

Total duration = 1m.

This was a very small local shock observed only at the Seismological Institute.

The P.T. lasted about 4s (?)

The P.P. began with the max. 2a of 0,1 mm in the EW and 0,05 mm in the NS component. In the EW component there was a second max. 2a of 0,1 mm 2s later on: in the other component the corresponding max. 2a was insignificant.

Eqke No. 227. November 7th 1899; 4h 48m 50s p.m. (Cent. Met. Obs. 4h 45m 54s. Slight).

Total duration = 1m 20s.

The P.T., which was well defined, lasted for 8,9s in the EW and 6,9s in the NS component, the motion consisting of extremely small and quick vibrations.

The P.P. began with a motion of 0,06 mm towards E and 0,05 mm towards S. The maximum motion, which occurred near the commencement of this portion was 0,08 mm in the EW and 0,1 mm in the NS component. There was a 2nd max. 2a of 5,8s later on, the displacement being better marked in the NS than in the EW component.

Eqke No. 241. December 14th 1899; 2h 29m 36s a.m.

Total duration = 2½m.

The motion was very small in both components.

The P.T. lasted for 18s in the EW and for 12,4s in the NS component.

P.O. There existed slight P.O., whose maximum motion was 0,02 mm in each component, and whose average period was 3,9s.

GROUP IX.—*Earthquakes of miscellaneous origins.*

Eqke No. 5.—July 25th 1898; 6h 18m 2s a.m.

Total duration = 30m.

Observations at Meteorological Observatories :—

Niigata .. .. .. 6h 19m 13s a.m. Slight.

The P.T., whose duration was 15s, began with a small displacement towards SW. The motion consisted essentially of vibrations of an average period of 1,2s, superposed with small quicker ones. The max. 2a was 0,19 mm in the EW and 0,13 mm in the NS component.

The P.P., whose duration was 3m 28s, was particularly active during the first 1m 36s and superposed with quicker vibrations. The motion began with a well defined displacement of 0,6 mm towards E and 0,7 mm towards N, the predominating average period being 5,2s. The max. (abs.) motion occurred at 34s from the commencement and had a period of 5,4s, its 2a being 2,2 mm in the EW and 1,7 mm in the NS component.

The E.P. The average period was 6,5s.

Eqke No. 212. October 7th 1899; 0h 59m 38s a.m.

Total duration = ?

Observations at Meteorological Observatories :—

Akita	0h 53m 28s a.m.	Weak.	Accompanied by vertical motion.
Aomori	0. 55. 35	„	Motion quick.
Hakodate ..	0. 56. 20	Slight.	
Miyako.. ..	0. 57. 1	„	Motion gentle.
Fukushima ..	1. 0. 8	„	

This was a small earthquake, whose diagram was altogether confused by very powerful P.O.

Eqke No. 216. October 11th 1899; 2h 17m 20s p.m.

Total duration = 14m.

Observations at Meteorological Observatories:—

Hiroshima	2h 14m 21s p.m.	Weak.	Houses shaken
Hamada .. .	2. 14. 26	,,	Duration long.
Sakai	2. 14. 40	,,	Motion quick.
Okayama	2. 14. 50	,,	,,
Matsumoto .. .	2. 15. 0	,,	
Yagi	2. 14. 5	Slight.	
Kumamoto	2. 14. 40	,,	
Tadotsu	2. 14. 40	,,	Motion quick.
Kure	2. 14. 57	,,	,,
Osaka	2. 15. 0	,,	,,
Fukuoka	2. 15. 28	,,	
Akamagaseki ..	2. 17. 21	,,	
Kochi	2. 23. 0 (?)	,,	

The P.T., whose duration was 45s, consisted of small vibrations of an average period of 3,5s.

The P.P., whose duration was about 1¼m, consisted of regular vibrations of an average period of 7,7s. The max. 2a, which occurred near the commencement, was 0,06 mm in the EW and 0,07 mm in the NS component.

Eqke No. 225. November 6th 1899; 0h 34m 0s a.m.

Total duration = 20m.

Observations at Meteorological Observatories:—

Hakodate...	0h 31m 24s a.m.	Weak.	Motion gentle.

(NS component).

The commencement was somewhat obscured by slight P.O. The earthquake began with small movements, the first max. 2a of 0,2 mm occurring at about 1¼m from the assumed start. A second max. 2a of 0,15 mm occurred 1m 55s later on. The average period in the P.P., which lasted 2¼m, was 14,4s. There were also traces of superposed smaller vibrations of an average period of about 3,5s.

The E.P. The average period was 8,4s.

P.O. There were very slight P.O., whose average period was 4,4s.

(The EW component record is missing).

印刷所　三秀社活版所
東京市神田區美土代町二丁目一番地

印刷者　島連太郎
東京市神田區美代代町二丁目一番地

震災豫防調査會

明治三十四年二月十一日發行
明治三十四年二月八日印刷

PUBLICATIONS

OF THE

Earthquake Investigation Committee

IN

FOREIGN LANGUAGES.

NO. 8.

TOKYO, 1902.

PUBLICATIONS

OF THE

Earthquake Investigation Committee

IN

FOREIGN LANGUAGES.

NO. 8.

TŌKYŌ, 1902.

ANNUAL AND DIURNAL VARIATIONS OF SEISMIC FREQUENCY IN JAPAN.

BY

F. OMORI, D. Sc.,

Member of the Imperial Earthquake Investigation Committee.

ANNUAL AND DIURNAL VARIATIONS OF SEISMIC FREQUENCY IN JAPAN.

BY

F. OMORI, D. Sc.,

Member of the Imperial Earthquake Investigation Committee.

I. INTRODUCTION.

1. *Time distribution of earthquakes.* The primary causes of earthquakes are certain abnormal stresses existing in the earth's crust, which gradually reach their maximum limit and produce some sudden geotectonic convulsions. Further, the atmospheric pressure, the attraction of the moon, etc., are to be regarded as periodic external forces acting on the earth's crust, which may accelerate the growth of the subterranean strains. Consequently we may assume that the seismic activity of the earth's crust must vary with time, subject to certain periodic fluctuations. Speaking generally, therefore, the time relation of the seismic frequency may be two-fold: firstly, non-periodic variations; and, secondly, periodic variations.

2. *Periodic seismic variations. Seismic frequency* means the number of earthquakes which are felt at a given place in a definite time interval, such as 1 hour, 1 day, 1 month, 1 year, etc.

One of the most satisfactory ways of finding out some of seismic periodicities is the consideration of the *after-shocks* of great earthquakes; because, firstly, these shocks are so numerous, and, secondly, the earth's crust at the earthquake origin or at its immediate vicinity must be

---

* This is the translation of my paper written in March 1900 and published in Vol. XXX of the *Report* (Japanese) *of the Imperial Earthquake Investigation Committee.*

particularly sensitive to the action of external agencies. I give below the results respecting the periodicity obtained in this way.*

After shocks of	Periods.
Kumamoto eqke of July 28th 1899.	4,6 days, 12 days, 33 days, 3 months.
Mino-Owari eqke of Oct. 28th 1891.	4 (or 4½) hours, 8 (or 9) hours, 1 day, 4½ days, 12 days, 33 days.
Kagoshima eqke of Sept. 7th 1893.	4,4 days, 12 days, 33 days.

Thus there seems to exist, beside the well known annual period, six others more or less accurately defined. Of these the two periods of 4 (or 4½) hours and 8 (or 9) hours are approximately ⅙th and ⅓rd of the diurnal period.

In the present paper I confine myself to the consideration of the annual and diurnal variations of seismic frequency in Japan.

3. The discussions in the present paper are based on earthquake observations at the following 26 Meteorological Observatories: *Nemuro Sapporo, Hakodate, Akita, Yamagata, Miyako, Ishinomaki, Fukushima, Utsunomiya, Tokyo, Maebashi, Niigata, Nagano, Numazu, Hamamatsu, Nagoya, Gifu, Hikone, Tsu, Wakayama, Hiroshima, Hamada, Kochi, Oita, Kumamoto* and *Kagoshima*. Of these 26 observatories, which are distributed in the principal seismic regions of the Empire, Gifu has recorded the maximum earthquake number of 4220, between Oct. 28th 1891 and Dec. 31st 1899; on the other hand, Hamada has recorded the fewest number of 30, between 1893 and 1899. The total number of earthquakes observed at these 26 places, up to the end of Dec. 31st 1899, amounts to 18279.

The majority of the 18279 earthquakes were observed instrumentally,

* See the present author's paper: "*On after shocks of earthquakes*" Jour. Sc. Coll. Imp. Univ. Tokyo. Vol. VII.

the seismographs used being those of the Gray-Milne type. These machines are essentially designed for the purpose of the macroseismic observation, and the multiplication of their pointers varies between 3 and 10.

The time distribution of earthquakes may not necessarily be similar for the whole of Japan. Consequently I have not mixed up all the records, but constructed the tables of monthly and hourly earthquake distribution separately for the different stations. The reader is also referred to Jour. Sc. Coll., Imp. Univ., Tokyo, Vol. XI, in which I have discussed the annual variation of the seismic frequency for Japan taken as a whole, with respect to *destructive* and *ordinary small* earthquakes.

4. *Meteorological Observatories.* The 25 meteorological observatories are for the sake of convenience divided into two groups (A) and (B). (See § 7.) In the following table are given for each station the date of commencement of earthquake observation, number of earthquakes observed etc. For the geographical position of the different Meteorological Observatories* the reader is referred to Fig. 16, and also to p.p. v–vii *Publication*, No. 6.

---

* At present there are in Japan 78 Meteorological Observatories.

TABLE I.

EARTHQUAKE OBSERVATION AT THE 26 METEOROLOGICAL STATIONS.

Group.	Meteorological Station.	Date of commencement of earthquake observation.		Time interval between Dec. 1899 and the commencement of earthquake observation. years.	months.	Date of setting up of Seismograph.		Total number of earthquakes observed.
A	Sapporo.	Sep.	1876	23	4	Jan.	1883	156.
	Hakodate.	Jan.	1873	27	0	Jan.	1895†	305.
	Tokyo.	Jan.	1876	24	0	(All instrumentally observed.)		2173.
	Niigata.	April	1886	13	9	Jan.	1894	216.
	Nagano.	March	1889	10	10	April	1889	310.
	Numazu.	Dec.	1884	15	1	(No seismograph yet set up)		162.
	Hamamatsu.	Jan.	1885	15	0	,,		99.
	Nagoya.	Oct.	1891*	8	3	(All instrumentally observed.)		1980.
	Gifu.	,,	*	,,	,,	,,		4216.
	Tsu.	July	1889	10	6	Feb. 1st, 1899		416.
	Wakayama.	Sep.	1879	20	4	Jan.	1888	404.
	Hiroshima.	Dec.	1884	15	1	Dec.	1892	107.
	Oita.	Jan.	1887	13	0	Jan.	1888	264.
	Kumamoto.	July	1889	10	6	Feb.	1890	1578.
	Kagoshima.	March	1885	14	10	Nov.	1887	406
	Nemuro.	Jan.	1885	15	0	Aug.	1886	1343.
	Akita.	Jan.	1883	17	0	July	1894	373.
	Yamagata.	Dec.	1889	10	1	,,	1889	197.
	Miyako.	March	1883	16	10	June	1896	704.
	Ishinomaki.	Jan.	1886	14	0	July	1896	1034.
	Fukushima.	May	1889	10	8	March	1895	857.
	Utsunomiya.	Jan.	1891	9	0	July	1893	492.
	Maebashi.	Dec.	1896	3	1	(All instrumentally observed.)		126.
	Hikone.	Jan.	1894	6	0	,,		245.
	Hamada.	Feb.	1893	6	11	July	1894	30.
	Kochi.	Feb.	1879	16	11	Dec.	1893	86.

Total number of earthquake observations = 18279.

* For Gifu and Nagoya I have taken here only the earthquakes which happened since the great Mino-Owari earthquake of Oct. 28th 1891.

† Observed since July 1831 by means of a dulplex pendulum seismograph.

From the above table it will be seen that the longest series of seismic observation were made at the following four stations :—*Hakodate*, 27 years; *Tokyo*, 24 years; *Sapporo*, 23 years 4 month; *Wakayama*, 20 years 4 months.

II. ANNUAL VARIATION OF EARTHQUAKE FREQUENCY.

5. *Seismic frequency at Tokyo and Gifu.* Let us first consider, as examples, the annual variation of seismic frequency at Tokyo and Gifu. The successive monthly earthquake numbers at each of these two places, when drawn in curves, indicate at once the annual and semi-annual periods.

The method of curve drawing here adopted is as follows.—Let y represent the seismic frequency corresponding to x, the time, which latter is generally expressed in months or seasons. Mark down on a section paper so many points (×) corresponding to the different sets of x and y. Then the curve is obtained by drawing a continuous free-hand line, which passes through the mean positions of every two consecutive points (×) and is everywhere tangential to the broken line connecting directly the points themselves.

The earthquake observation in Tokyo has been done all instrumentally* and furnishes us with a very important material for the question under consideration, as they are not affected by any circumstance which may render the accuracy of the observation non-uniform in the different parts of the year or of the day.

Fig. 1, (*A*), (*B*), (*C*), (*D*), give the graphical representation of the variation of the successive monthly earthquake numbers in Tokyo, between Jan. 1876 and Dec. 1899. The dotted lines in (*A*), (*B*) and (*D*),

* At first Palmieri's Seismograph was used, but since 1887 the Gray-Milne instrument has been used at the Central Meteorological Observatory as standard macroseismic instrument.

drawn through the mean positions of the original curves, indicate very clearly the annual period. On the other hand, the curve in (C) clearly indicates the semi-annual period.

Fig. 3 gives the curve of the monthly earthquake numbers at Gifu, which indicates on the whole the semi-annual period. For the sake of comparison, I give in the same figure the curves of the monthly earthquake numbers at Nemuro and Nagoya. It will be seen that the Nemuro curve is approximately similar to the Gifu curve so far as the number and form of the fluctuations are concerned. On the other hand, the two curves for Gifu and Nagoya, although more or less similar, are sometimes rather opposite to each other, as, for instance, at a and b. This indicates that the variation of seismic frequency may not necessarily be exactly the same even for places quite near to one another.

6. *Monthly and seasonal seismic frequencies at the different places.*

Tables II, (A, 1-15) and (B, 1-11), which have been constructed from the original records of seismic observatories, give, for each of the latter, successive monthly and yearly earthquake numbers as well as mean monthly and seasonal seismic frequencies.

The mean monthly seismic frequency for each station has been obtained by adding together all the earthquake numbers for a given month of the year and by dividing the sum so deduced by the number of the years taken into account.

In the calculation of a mean monthly seismic frequency at a given station I have excluded those months, whose seismic frequency was affected by the *after shocks* of a destructive or very strong earthquake at a comparatively near distance; the object being the estimation of the seismic frequencies for the different stations in *ordinary* times, when there is no destructive or great earthquake. The months thus excluded are each marked in the tables with an asterisk (*), and are as follows.—

List of the months excluded from the calculation of the mean monthly (and seasonal) seismic frequencies.

Place.	Month, Year.	Excluded on account of the after shocks of
Tokyo.	Oct. 1891. March 1894. June 1896. Aug. 1897.	Mino-Owari Eqke of Oct. 28th 1891. Hokkaido Eqke of March 22nd 1894. Eqke of June 15th 1896. „ „ Aug. 5th 1897.
Numazu and Hamamatsu.	Oct. 1891.	Mino-Owari Eqke of Oct. 28th 1891.
Nagoya and Gifu.	Oct. 1891 Dec. 1892. Jan.—Dec., 1894.	„ „ „ „ „ Eqke of Jan. 10th 1894.
Tsu.	Oct. 1891 March 1892.	Mino-Owari Eqke of Oct. 28th 1891.
Kumamoto.	July—Dec., 1889. Aug. -Dec., 1894. Aug.—Dec., 1895.	Kumamoto Eqke of July 28th 1889. „ „ „ Aug. 8th 1894. „ „ „ Aug. 27th 1895.
Kagoshima.	Sept. 1893. Jan. 1894.	Kagoshima Eqke of Sept. 7th 1893. „ „ „ Jan. 4th 1894.
Nemuro.	March—Dec., 1894.	Hokkaido Eqke of March 22nd 1894.
Akita.	Aug. and Sept., 1896.	Riku-U Eqke of Aug. 31st 1896.
Miyako.	June 1896. Sept. „ Feb. 1897. Aug. „	Eqke of June 15th 1896. Riku-U Eqke of Aug. 31st 1896. Sendai Eqke of Feb. 20th 1897. Eqke of Aug. 5th 1897.
Hikone.	Jan. 1894.	Eqke of June 10th 1894.

The mean seasonal seismic frequencies for each station have been btained from the mean monthly frequencies, as follaws :—

Seism. freq. for Spring = Sum of seism. freq. for March, April, May.

" Summer = " June, July, August.

" Autumn = " Sept., Oct., Nov.

" Winter = " Dec., Jan., Feb.

Further for each station the following abbreviations are used.

Monthly seismic frequency :—

a = Maximum monthly seismic frequency ;

b = Minimum " " " ;

c = Mean " " " ;

$d = a - b$ = Amplitude of variation of monthly seismic frequency ;

$e = \frac{d}{c}$ = Percentage amount of fluctuation of monthly seismic frequency.

Similarly for seasonal seismic frequency :—

A = Maximum seasonal seismic frequency ;

B = Minimum " " " ;

C = Mean " " " ;

$D = A - B$ = Amplitude of variation of seasonal seismic frequency ;

$E = \frac{D}{C}$ = Percentage amount of fluctuation of seasonal seismic frequency.

TABLE II (A, 1

MONTHLY EARTHQUAKE NUMBERS AT *SAPPORO*.

Sept. 1876—Dec. 1899.

Instrumentally observed since Jan. 1883.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Mean.
1876									1	0	0	1	2
1877	0	0	0	0	0	0	0	0	0	1	1	1	3
1878	0	0	0	1	0	0	1	1	0	0	1	0	4*
1879	0	0	1	0	0	0	0	0	0	0	0	0	1
1880	0	1	0	0	0	0	0	1	0	0	0	0	2
1881	0	3	0	2	0	0	0	0	0	1	0	0	6
1882	0	0	2	0	0	0	0	0	2	0	0	0	4
1883	1	2	0	2	0	2	2	2	0	2	4	0	17
1884	0	0	0	0	0	0	0	1	0	0	0	1	2
1885	0	0	1	0	0	1	2	0	2	2	0	0	8
1886	0	1	0	0	0	0	0	0	0	0	0	1	2
1887	0	0	1	0	0	0	0	1	0	0	0	0	2
1888	0	3	0	1	1	1	0	0	0	0	0	0	6
1889	1	0	0	0	0	0	0	0	1	0	0	0	2
1890	0	1	1	0	1	0	0	0	1	1	2	0	7
1891	0	0	0	0	0	1	0	0	0	1	0	0	2
1892	1	0	0	0	0	0	0	2	0	2	1	0	6
1893	0	0	2	0	0	3	0	0	0	1	1	2	9
1894	0	4	5	3	1	2	1	3	4	2	2	3	30
1895	3	0	0	2	0	0	0	1	1	1	1	1	10
1896	0	2	1	1	0	0	0	0	0	3	3	1	11
1897	0	1	0	0	1	0	0	0	0	3	0	0	5
1898	0	2	0	3	0	1	1	0	0	1	1	1	10
1899	0	0	0	2	2	0	0	0	1	0	0	0	5
Sum.	6	20	14	17	6	11	7	12	13	21	17	12	156
Mean	0.26	0.87	0.61	0.74	0.26	0.48	0.30	0.52	0.54	0.88	0.71	0.50	6.67

Spring (III, IV, V) 1.61
Summer (VI, VII, VIII) . . 1.30 (Min.) $= B$
Autumn (IX, X, XI) . . . . . 2.13 (Max.) $= A$
Winter (XII, I, II) 1.63

Mean Seasonal Number . . 1.67 . . . . . . $= C$

Warmer Months (IV-IX) . . 2.84 $D = A - B = 0.83$ $E = \frac{D}{C} = \frac{1}{2.01} = 50\%$

Colder Months (X-III) . . . 3.83 $d = a - b = 0.62$ $e = \frac{d}{c} = \frac{1}{0.90} = 111\%$

TABLE II (*A*, 2).

MONTHLY EARTHQUAKE NUMBERS AT *HAKODATE*.

Jan. 1873—Dec. 1899.

Instrumentally observed since Jan. 1895.

Year. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Mean.
1873	2	0	3	2	0	3	2	3	0	1	1	0	17
1874	2	5	1	0	1	1	0	0	0	1	1	0	12
1875	3	2	0	1	0	0	1	1	0	0	1	1	10
1876	0	0	0	1	0	0	1	0	1	0	1	2	6
1877	1	1	1	1	3	0	1	0	1	1	2	4	16
1878	1	0	1	0	0	1	1	1	3	0	1	0	9
1879	0	2	1	0	2	0	0	1	1	0	1	0	8
1880	0	1	1	0	0	1	0	2	2	0	0	1	8
1881	0	1	0	2	1	0	0	0	0	2	0	0	6
1882	0	0	2	0	0	1	0	0	0	0	1	1	5
1883	0	0	1	2	0	1	1	1	2	2	1	1	12
1884	1	1	0	0	2	1	0	2	1	0	3	1	12
1885	0	0	1	1	0	2	3	0	2	1	0	0	10
1886	0	0	0	0	1	0	1	0	0	0	1	0	3
1887	0	3	0	0	2	0	2	2	0	0	1	0	10
1888	1	1	0	0	0	0	0	0	1	2	1	1	7
1889	2	1	1	3	1	0	1	1	1	12	1	1	25
1890	0	0	1	0	1	1	0	0	0	0	5	0	8
1891	0	1	0	2	0	1	1	0	0	1	1	3	10
1892	2	0	0	1	0	0	1	2	0	2	0	0	8
1893	1	1	1	0	1	4	0	0	1	2	0	1	12
1894	0	3	5	3	3	2	1	0	0	2	3	1	23
1895	2	1	0	0	1	1	0	0	0	2	0	1	8
1896	1	3	0	5	1	3	1	1	2	2	1	0	20
1897	0	1	1	0	1	0	2	2	0	1	0	1	9
1898	1	0	2	2	0	1	0	1	1	3	3	3	17
1899	0	1	2	1	2	1	1	0	0	1	5	0	14
Sum.	20	29	25	27	23	25	21	20	19	38	35	23	305
Mean.	0.74	1.07	0.93	1.00	0.85	0.92	0.78	0.74	0.70	1.41	1.30	0.85	113.0

Spring (III, IV, V)........2.78
Summer (VI, VII, VIII)....2.45 (Min.) $=B$
Autumn (IX, X, XI).......3.41 (Max.) $=A$
Winter (XII, I, II)........2.66

Mean Seasonal Number ...2.82......$=C$

Warmer Months (IV–IX)..5.00 $\quad D=A-B=0.96 \quad E=\frac{D}{C}=\frac{1}{2.9}=34\%$

Colder Months (X–III)....6.30 $\quad d=a-b=0.71 \quad e=\frac{d}{c}=\frac{1}{1.3}=76\%$

TABLE II (*A, 3*).

MONTHLY EARTHQUAKE NUMBERS AT *TOKYO*.

Jan. 1876—Dec. 1899.

Instrumentally observed from the very beginning.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Mean.
1876	3	4	6	11	5	3	3	5	3	3	4	6	**56**
1877	4	5	6	5	8	9	6	4	1	8	6	9	**71**
1878	3	8	7	2	5	4	4	1	2	4	6	4	**50**
1879	6	7	14	0	9	4	3	4	1	7	6	9	**70**
1880	9	9	6	6	2	9	8	4	1	3	10	10	**77**
1881	13	8	8	8	4	3	3	3	2	3	3	8	**66**
1882	4	7	15	6	3	2	2	1	1	4	1	0	**46**
1883	6	0	3	3	6	2	3	1	0	1	3	4	**32**
1884	5	2	8	2	9	4	1	4	2	8	8	15	**68**
1885	7	9	8	4	3	6	0	3	8	10	3	7	**68**
1886	3	3	3	2	8	4	2	8	7	4	2	8	**54**
1887	10	4	3	8	13	5	6	2	10	0	5	14	**80**
1888	4	15	7	7	11	9	9	7	11	4	13	4	**101**
1889	5	16	11	18	13	7	5	8	7	8	9	6	**113**
1890	5	5	6	15	14	5	12	7	4	8	10	2	**93**
1891	1	4	6	7	10	7	8	4	4	* 45	12	15	**123**
1892	9	11	3	7	7	9	14	2	7	11	4	8	**92**
1893	5	4	5	7	10	10	4	3	6	3	3	1	**61**
1894	7	8	* 23	11	9	9	6	3	8	4	8	5	**101**
1895	20	9	8	17	11	12	11	5	10	17	6	3	**129**
1896	42	17	15	21	10	* 51	22	18	7	5	7	10	**225**
1897	11	18	11	8	17	6	11	* 32	5	8	15	22	**164**
1898	4	8	16	17	16	13	16	13	15	5	11	10	**144**
1899	7	11	17	13	6	9	8	16	8	8	13	8	**124**
Sum.	193	192	215	205	209	202	167	158	130	181	168	188	2208
Mean.	8.1	8.0	8.3	8.5	8.7	6.6	7.0	5.5	5.4	5.9	7.0	7.8	86.8

Spring (III, IV, V) ..... 25.5 (Max.) $= A$.
Summer (VI, VII, VIII) .. 19.1
Autumn (IX, X, XI) .... 18.3 (Min.) $= B$.
Winter (XII, I, II) 23.9

Mean Seasonal Number .. 21.7 ...... $= C$.

Warmer Months (IV–IX) .. 45.1 $\quad D = A - B = 7.2 \quad E = \frac{D}{C} = \frac{1}{3.0} = 33\%$

Colder Months (X–III) .... 41.7 $\quad d = a - b = 3.3 \quad e = \frac{d}{c} = \frac{1}{2.2} = 46\%$

TABLE II (*A. 4*).

MONTHLY EARTHQUAKE NUMBERS AT *NIIGATA*.

April. 1886—Dec. 1899.

Instrumentally observed since Jan. 1894.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1886				1	0	0	1	0	0	0	0	0	2
1887	0	0	0	0	0	0	2	0	0	0	0	0	2
1888	0	0	0	0	0	0	1	0	0	0	0	0	1
1889	0	0	1	0	0	0	0	0	0	0	0	0	1
1890	1	0	0	0	0	0	0	0	0	0	0	0	1
1891	2	1	0	29	9	4	0	0	1	2	0	0	48
1892	0	0	0	0	0	1	0	0	0	0	3	2	6
1893	0	0	1	0	0	0	0	0	0	0	0	0	1
1894	0	2	2	1	0	2	0	2	0	8	8	0	25
1895	1	0	0	1	1	0	5	0	0	2	0	0	10
1896	2	1	0	5	1	2	2	5	12	2	2	0	34
1897	3	5	2	4	11	14	2	5	2	3	0	4	55
1898	2	1	4	2	7	6	2	0	0	3	0	0	27
1899	1	1	1	0	0	0	0	0	0	0	0	0	3
Sum.	12	11	11	43	29	29	15	12	15	20	13	6	212
Mean.	0.92	0.85	0.85	3.07	2.07	2.07	1.07	0.86	1.07	1.43	0.93	0.43	15.62

Spring (III, IV, V) ...... 5.99 (Max.) $= A$
Summer (VI, VII, VIII) . 4.00
Autumn (IX, X, XI) 3.43
Winter (XII, I, II) ..... 2.20 (Min.) $= B$

Mean Seasonal Number .. 3.90 ...... $= C$

$$D = A - B = 3.79 \qquad E = \frac{D}{C} = \frac{1}{1.03} = 97\%$$

$$d = a - b = 2.64 \qquad e = \frac{d}{c} = \frac{1}{0.49} = 203\%$$

Warmer Months (IV–IX).... 10.21
Colder Months (X–III)...... 5.41

TABLE II (*A, 5*).

MONTHLY EARTHQUAKE NUMBERS AT *NAGANO*

March 1889—Dec. 1899.

Instrumentally observed since April 1889.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1889			1	0	1	0	0	0	0	1	0	0	**3**
1890	2	0	0	1	0	1	0	0	1	0	0	0	**5**
1891	0	0	0	0	1	0	0	0	0	2	1	3	**7**
1892	2	5	1	0	0	1	1	0	2	2	2	5	**21**
1893	0	2	2	0	3	0	4	3	2	5	5	3	**29**
1894	7	0	3	8	2	2	2	1	1	3	2	0	**31**
1895	3	0	1	0	0	0	0	0	1	1	0	0	**6**
1896	2	4	2	2	0	1	3	3	1	0	1	1	**20**
1897	6	3	2	12	27	4	5	1	4	3	4	3	**74**
1898	0	3	3	1	1	2	3	1	0	17	9	7	**47**
1899	4	14	17	8	13	5	1	1	0	2	2	0	**67**
Sum.	26	31	32	32	48	16	19	10	12	36	26	22	**310**
Mean.	2.6	3.1	2.9	2.9	4.4	1.5	1.7	0.9	1.1	3.3	2.4	2.0	**28.8**

Spring (III, IV, V) .....10.2 (Max.) $= A$
Summer (VI, VII, VIII) .. 4.1 (Min.) $= B$
Autumn (IX, X, XI)...... 6.8
Winter (XII, I, II).. .... 7.7

Mean Seasonal Number... 7.2 ...... $= C$

$D = A - B = 6.1$ $\qquad E = \dfrac{D}{C} = \dfrac{1}{1.17} = 86\%$

$d = a - b = 3.5$ $\qquad e = \dfrac{d}{c} = \dfrac{1}{0.71} = 140\%$.

Warmer Months (IV–IX)......12.5
Colder Months (X–III)........16.3

TABLE II (*A*, 6).

MONTHLY EARTHQUAKE NUMBERS AT *NUMAZU*.

Dec. 1884—Dec. 1899.

Observed non-instrumentally.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1884												2	2
1885	1	2	2	0	0	2	0	0	4	1	1	0	13
1886	0	0	1	0	1	0	0	0	0	0	0	0	2
1887	5	1	0	0	0	0	1	0	1	0	0	0	8
1888	0	0	2	2	1	3	0	0	0	0	0	0	8
1889	1	1	0	2	1	1	0	0	0	2	0	1	9
1890	2	0	1	2	0	0	1	2	2	0	1	2	13
1891	0	2	1	0	0	0	0	0	1	8	0	3	15
1892	2	1	1	0	0	2	0	0	1	1	2	0	10
1893	1	0	2	0	0	0	0	1	1	0	0	0	5
1894	4	1	1	1	1	1	0	0	1	1	1	0	12
1895	2	0	0	2	0	0	0	0	2	0	0	0	6
1896	2	4	1	1	3	0	1	1	0	0	0	0	13
1897	1	1	3	0	2	0	2	2	1	2	0	1	15
1898	0	1	5	4	0	2	3	1	1	1	3	0	21
1899	1	1	1	2	1	1	0	0	0	2	1	0	10
Sum.	22	15	21	16	10	12	8	7	15	18	9	9	162
Mean.	1.5	1.0	1.4	1.1	0.7	0.8	0.5	0.5	1.0	0.7	0.6	0.6	10.4

Spring (III, IV, V) .....3.2 (Max.) = A
Summer (VI, VII, VIII)..1.8 (Min.) = B
Autumn (IX, X, XI).. .2.3
Winter (XII, I, II) .. 3.1

Mean Seasonal Number..2.6.... . = C

$$D = A - B = 1.4 \qquad E = \frac{D}{C} = \frac{1}{1.9} = 54\%$$

$$d = a - b = 1.0 \qquad e = \frac{d}{c} = \frac{1.}{0.9} = 111\%$$

Warmer Months (IV-IX).......4.6

Colder Months (X-III).........5.8

TABLE II (*A*, 7).

MONTHLY EARTHQUAKE NUMBERS AT *HAMAMATSU.*

Jan. 1885—Dec. 1899.

Observed non-instrumentally.

Months. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	**Sum.**
1885	0	1	0	0	0	0	0	1	2	1	0	0	**5**
1886	1	0	0	1	0	0	0	0	0	0	0	0	**2**
1887	3	3	0	1	0	0	0	0	0	1	0	0	**8**
1888	0	0	0	0	1	0	1	0	0	0	1	0	**3**
1889	0	0	0	2	2	1	0	0	0	1	0	0	**6**
1890	1	0	0	2	0	0	0	0	0	0	0	0	**3**
1891	0	0	0	0	0	0	0	0	0	* 20	13	6	**39**
1892	2	3	1	0	1	1	0	0	1	0	0	0	**9**
1893	0	0	0	0	0	1	0	0	0	1	0	0	**2**
1894	3	0	0	0	0	1	0	0	0	0	0	0	**4**
1895	1	1	0	1	1	0	0	1	0	1	0	0	**6**
1896	0	0	0	0	1	0	0	0	0	0	0	0	**1**
1897	0	1	0	1	0	0	0	0	0	0	0	1	**3**
1898	0	0	0	2	0	0	0	0	0	0	2	0	**4**
1899	1	0	3	0	0	0	0	0	0	0	0	0	**4**
Sum.	12	9	4	10	6	4	1	2	3	25	16	7	**99**
Mean.	0.80	0.60	0.27	0.67	0.40	0.27	0.07	0.13	0.20	0.36	1.07	0.47	**5.31**

Spring (III, IV, V)......1.34
Summer (VI, VII, VIII)..0.47 (Min.)$=B$
Autumn (IX, X, XI) 1.63
Winter (XII, I, II) ......1.87 (Max.)$=A$

Mean Seasonal Number..1.33 ...... $=C$

$D=A-B=1.40$ $\qquad E=\frac{D}{C}=\frac{1}{0.95}=105\%$

$d=a-b=1.00$ $\qquad e=\frac{d}{c}=\frac{1}{0.44}=227\%$

Warmer Months (IV–IX)......1.74

Colder Months (X–III).. . . ...3.57

TABLE II (A, 8).

MONTHLY EARTHQUAKE NUMBERS AT *NAGOYA*.

Oct. 29th 1891—Dec. 1899.

All instrumentally observed.

Months. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1891										*332	*467	*113	852
1892	*43	*29	*16	*11	*11	*12	*4	*15	13	*12	*15	*15	196
1893	8	5	11	11	16	9	14	14	8	9	4	8	117
94	*90	*29	*31	*19	*10	*19	*12	*17	19	*19	*10	*11	286
1895	31	16	18	10	11	8	5	2	8	20	7	7	143
1896	16	8	24	12	6	9	3	7	13	0	5	6	109
1897	6	5	6	3	9	4	1	20	3	4	2	2	65
1898	3	3	3	7	1	1	5	10	1	1	3	4	42
1899	5	2	6	7	4	2	3	5	1	2	4	3	44
Sum.	202	97	115	80	68	64	47	90	66	399	457	169	1854
Mean.	11.5	6.5	11.3	8.3	7.8	5.5	2.5	9.7	5.7	6.0	4.2	5.0	86.7

Spring (III, IV, V) ...... 27.4 (Max.) = A
Summer (VI, VII, VIII) .. 20.4
Autumn (IX, X, XI)... .15.9 (Min.) = B
Winter (XII, I, II) 23.0

Mean Seasonal Number ..21.7.. .. = C

$D = A - B = 11.5$ $\qquad E = \frac{D}{C} = \frac{1}{1.9} = 53\%$

$d = a - b = 7.3$ $\qquad e = \frac{d}{c} = \frac{1}{1.0} = 100\%$

Warmer Months (IV–IX).... .. 42.2

Colder Months (X–III)...... ...44.5

TABLE II (*A*, *9*).

MONTHLY EARTHQUAKE NUMBERS AT *GIFU*

Oct. 29th 1891—Dec. 1899.

All instrumentally observed.

Month / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1891										617	*1086	*416	2119
1892	*164	*114	*87	*90	*54	*30	*35	*52	*107	*47	*48	*39	867
1893	31	20	52	59	32	12	18	13	20	19	16	16	308
1894	*62	*14	*19	*8	*5	*16	19	*19	*12	*6	*29	*20	229
1895	21	17	10	24	19	18	8	10	14	18	6	7	172
1896	12	9	4	9	4	14	17	10	10	9	7	13	118
1897	22	15	11	6	20	7	2	7	8	9	22	8	137
1898	6	6	9	15	6	9	5	6	5	13	16	5	101
1899	4	7	3	12	2	2	4	3	1	5	10	9	62
Sum.	322	202	195	223	142	108	108	120	177	743	1240	533	4113
Mean.	16.0	12.3	14.8	20.8	13.8	10.3	9.0	8.2	9.7	12.2	12.8	9.7	149.6

Spring (III, IV, V) ......49.4 (Max.) $= A$
Summer (VI, VII, VIII) ..27.5 (Min.) $= B$
[illegible]
Winter (XII, I, II) 38.0

Mean Seasonal Number ..37.4......$= C$

$D = A - B = 21.9$ $\qquad E = \frac{D}{C} = \frac{1}{1.7} = 59\%$

$d = a - b = 12.6$ $\qquad e = \frac{d}{c} = \frac{1}{1.0} = 100\%$

Warmer Months (IV–IX)........71.8

Colder Months (X–III)...........77.8

TABLE II (*A, 10*).

MONTHLY EARTHQUAKE NUMBERS AT *TSU.*

July 1889—Dec. 1899.

Instrumentally observed since Feb. 1898.

Month. / Year.	I.	II.	III.	VI.	V.	VI.	VII.	VIII	IX.	X.	XI.	XII.	Sum.
1889							1	2	2	4	0	0	9
1890	1	0	3	1	0	1	0	1	2	0	4	5	18
1891	1	1	2	0	0	0	1	1	0	*141	*89	*24	260
1892	*12	*10	*7	4	1	1	1	7	2	4	0	4	53
1893	2	2	1	1	1	2	0	0	0	0	1	1	11
1894	12	1	1	0	1	1	0	0	0	0	3	1	20
1895	1	2	0	1	1	0	0	1	0	1	0	0	7
1896	1	0	0	0	1	1	1	0	0	0	0	0	4
1897	0	0	0	0	1	0	0	0	0	0	0	0	1
1898	1	0	1	2	0	0	0	1	0	0	2	1	8
1899	1	1	11	6	1	0	2	0	1	0	1	1	25
Sum.	32	17	26	15	7	6	6	13	7	150	100	37	416
Mean.	2.2	0.8	2.1	1.5	0.7	0.6	0.5	1.2	0.6	0.9	1.1	1.3	13.5

Spring (III, IV, V) . 4.3 (Max.) $= A$
Summer (VI, VII, VIII) . 2.3 (Min.) $= B$
Autumn (IX, X, XI) . . . 2.6
Winter (XII, I, II) . . . . . 4.3 (Max.) $= A$

Mean Seasonal Number . . . 3.4 . . . . . . $= C$

$D = A - B = 1.7$ $\qquad E = \frac{D}{C} = \frac{1}{2.00} = 50\%$

$d = a - b = 1.7$ $\qquad e = \frac{d}{c} = \frac{1}{0.65} = 155\%$

Warmer Months (IV–IX) 5.1

Colder Months (X–III) 8.4

TABLE II (*A, 11*).

MONTHLY EARTHQUAKE NUMBERS AT *WAKAYAMA*.

Sept. 1879—Dec. 1899.

Instrumentally observed since Jan. 1888.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1879									2	0	0	1	**3**
1880	0	0	0	1	2	2	2	0	0	1	0	1	**9**
1881	0	0	1	1	1	1	2	0	0	0	0	0	**6**
1882	1	1	0	1	2	0	1	2	1	0	1	0	**10**
1883	1	0	2	1	2	0	2	2	3	2	1	0	**16**
1884	1	3	2	2	2	1	1	2	5	2	1	6	**28**
1885	0	2	1	0	3	1	2	2	2	1	1	1	**16**
1886	4	1	4	1	4	2	0	0	1	3	2	0	**22**
1887	0	2	0	3	0	1	2	1	2	0	1	1	**13**
1888	2	0	0	1	3	1	2	0	2	3	1	1	**16**
1889	2	3	2	1	2	0	1	0	0	1	0	1	**13**
1890	1	2	1	1	0	0	1	0	1	0	1	1	**9**
1891	1	0	0	2	2	2	2	3	1	5	5	2	**25**
1892	3	2	1	3	2	3	1	1	2	2	1	0	**21**
1893	1	0	2	1	1	0	1	1	1	1	5	2	**15**
1894	4	1	6	3	3	2	2	2	2	2	0	3	**30**
1895	9	3	0	2	0	1	2	1	1	2	1	2	**24**
1896	0	1	1	2	7	3	6	1	1	2	3	0	**27**
1897	4	2	1	3	5	4	3	4	5	0	2	0	**33**
1898	2	0	3	6	4	5	1	2	2	1	2	3	**31**
1899	2	2	14	3	1	3	4	4	0	2	3	1	**39**
Sum.	37	25	41	38	46	32	38	28	34	30	31	26	**406**
Mean.	1.8	1.2	2.0	1.9	2.3	1.6	1.9	1.4	1.7	1.4	1.5	1.2	19.9

Spring (III, IV, V) . . . . . . 6.2 (Max.) $= A$
Summer (VI, VII, VIII) . 4.9
Autumn (IX, X, XI) 4.6
Winter (XII, I, II) . . . . . . 4.2 (Min.) $= B$

Mean Seasonal Number . 4.9 . . . . . . $= C$

Warmer Months (IV-IX) . . 10.8 $\quad D = A - B = 2.0 \quad E = \frac{D}{C} = \frac{1}{2.5} = 40\%$

Colder Months (X-III) . . . 9.1 $\quad d = a - b = 1.1 \quad e = \frac{d}{c} = \frac{1}{1.5} = 67\%$

TABLE II (A, 12).

MONTHLY EARTHQUAKE NUMBERS AT *HIROSHIMA*.

Dec. 1884--Dec. 1899.

Instrumentally observed since Feb. 1892.

Month. / Year	I.	II.	III.	IV.	V	VI.	VII	VIII.	IX.	X.	XI.	XII.	Sum.
1884												1	1
1885	0	0	1	0	0	1	0	0	0	1	2	0	5
1886	0	0	0	0	0	1	0	1	0	0	0	0	2
1887	3	2	1	1	2	0	0	1	0	1	1	0	12
1888	1	0	0	1	1	1	0	0	0	0	2	2	8
1889	1	1	1	0	1	0	3	0	0	0	0	0	7
1890	1	0	0	0	0	1	0	0	0	0	0	0	2
1891	0	0	1	0	1	0	2	2	0	2	0	0	8
1892	2	0	0	0	0	0	0	0	2	1	0	0	5
1893	0	3	0	0	0	0	1	0	1	0	0	1	6
1894	0	0	0	2	3	0	0	1	0	1	1	0	8
1895	1	2	0	0	0	0	1	2	0	2	1	0	9
1896	0	1	0	1	0	0	0	1	1	1	1	0	6
1897	1	0	0	1	0	0	1	0	1	0	1	0	5
1898	0	1	0	4	0	0	1	0	1	1	1	3	12
1899	2	1	2	0	1	1	0	0	0	2	2	0	11
Sum.	12	11	6	10	9	5	9	8	6	12	12	7	107
Mean.	0.8	0.7	0.4	0.7	0.6	0.3	0.6	0.5	0.4	0.8	0.8	0.4	7.0

Spring (III, IV, V)......1.7
Summer (VI, VII, VIII)..1.4 (Min.) $=B$
Autumn (IX, X, XI).. .2.0 (Max.) $=A$
Winter (XII, I, II) .. 1.9

Mean Seasonal Number..1.75..... $=C$

$D=A-B=0.6$ $\qquad E=\frac{D}{C}=\frac{1}{2.9}=86\%$

$d=a-b=0.5$ $\qquad e=\frac{d}{c}=\frac{1.}{1.2}=34\%$

Warmer Months (IV–IX).......3.1

Colder Months (X–III).........3.9

TABLE II (*A, 13*).

MONTHLY EARTHQUAKE NUMBERS AT *OITA*.

Jan. 1887—Dec. 1899.

All instrumentally observed.

Month. / Year	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1887	1	0	0	1	0	1	0	1	2	1	0	0	7
1888	1	0	0	2	2	0	0	4	2	2	2	4	19
1889	6	4	5	1	5	2	8	6	1	1	2	1	42
1890	2	0	2	4	1	3	3	2	0	4	3	5	29
1891	2	5	6	8	1	1	2	1	0	12	17	5	60
1892	1	4	1	2	0	0	0	0	2	1	0	0	11
1893	0	1	0	0	0	0	0	0	3	2	0	1	7
1894	4	0	0	1	0	2	0	1	0	0	0	0	8
1895	1	0	3	0	2	1	0	1	0	1	1	0	10
1896	1	2	0	2	1	2	0	2	0	0	0	0	10
1897	2	1	1	1	0	0	1	1	2	0	2	0	11
1898	0	1	1	2	0	0	2	5	3	3	2	5	24
1899	2	5	3	4	0	2	2	2	1	1	2	2	26
Sum.	23	23	22	28	12	14	18	26	16	28	31	23	264
Mean.	1.8	1.8	1.7	2.2	0.9	1.1	1.4	2.0	1.2	2.2	2.4	1.8	20.5

Spring (III, IV, V)......4.8
Summer (VI, VII, VIII)..4.5 (Min.) = B
Autumn (IX, X, XI).. ..5.8 (Max.) = A
Winter (XII, I, II)......5.4

Mean Seasonal Number ..5.1...... = C

$D = A - B = 1.3$ $\qquad E = \frac{D}{C} = \frac{1}{3.9} = 25\%$

$d = a - b = 1.5$ $\qquad e = \frac{d}{c} = \frac{1}{1.1} = 88\%$

Warmer Months (IV–IX).......8.8
Colder Months (X–III)......11.7

TABLE II (*A, 14*).

MONTHLY EARTHQUAKE NUMBERS AT *KUMAMOTO*.

July 1889—Dec. 1899.

Instrumentally observed since Feb. 1890.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1889							*113	*243	*41	*77	*51	*41	566
1890	15	8	39	16	34	26	20	19	14	6	7	3	207
1891	8	19	6	9	7	7	2	1	0	11	9	9	88
1892	3	3	3	3	7	3	4	1	2	5	3	2	39
1893	2	1	1	1	0	1	0	0	9	8	3	0	26
1894	7	4	0	0	2	2	2	*123	*37	*13	*17	*12	219
1895	7	10	3	14	8	6	0	*34	*30	*22	*21	*7	162
1896	19	16	10	10	9	13	0	10	7	13	1	3	111
1897	5	1	6	6	2	6	4	3	6	6	2	8	55
1898	7	6	2	10	10	6	3	10	7	2	6	6	75
1899	9	2	4	2	0	2	2	1	0	2	6	2	32
Sum.	82	70	74	71	79	72	150	445	153	165	126	93	1578
Mean.	8.2	7.0	7.4	7.1	7.9	7.2	3.7	5.6	5.6	6.6	4.6	4.1	75.0

Spring (III, IV, V)......22.4 (Max.) $=A$
Summer (VI, VII, VIII) .16.5 (Min.) $=B$
Autumn (IX, X, XI) 16.8
Winter (XII, I, II)......18.3

Mean Seasonal Number..18.8 ... $=C$

$D=A-B=5.9$ $\qquad E=\frac{D}{C}=\frac{1}{3.2}=31\%$

$d=a-b=4.5$ $\qquad e=\frac{d}{c}=\frac{1}{1.4}=71\%$

Warmer Months (IV–IX). .37.1
Colder Months (X–III)... .37.9

TABLE II (*A, 15*).

MONTHLY EARTHQUAKE NUMBERS AT *KAGOSHIMA*.

March 1885—Dec. 1899.

Instrumentally observed since Nov. 1888.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1885			1	0	0	1	0	1	1	1	1	1	**7**
1886	2	1	1	0	0	0	1	1	1	1	0	0	**8**
1887	3	1	0	2	0	0	1	0	0	0	2	1	**10**
1888	4	9	6	6	0	1	0	1	3	9	2	6	**47**
1889	3	0	2	0	0	1	1	5	6	6	1	3	**28**
1890	1	5	0	2	9	3	3	5	1	1	0	2	**30**
1891	0	3	1	1	0	1	2	0	2	3	0	0	**13**
1892	0	1	3	2	1	1	0	1	0	2	0	0	**11**
1893	0	0	0	1	1	0	0	1	* 17	3	1	4	**28**
1894	* 24	4	8	4	0	0	0	2	0	0	0	0	**42**
1895	1	0	1	2	1	2	1	4	1	2	2	0	**17**
1896	0	1	0	6	11	3	1	1	0	0	1	4	**28**
1897	0	0	0	3	0	0	0	0	2	1	1	1	**8**
1898	0	0	0	2	3	5	0	3	2	4	14	6	**39**
1899	7	9	5	20	4	7	11	4	13	8	2	0	**90**
Sum.	45	34	28	51	30	25	21	27	49	41	27	28	**406**
Mean.	1.6	2.4	1.9	3.4	2.0	1.7	1.4	1.8	2.3	2.7	1.8	1.9	24.9

Spring (III, IV, V)..... 7.3 (Max.) = A
Summer (VI, VII, VIII).. 4.9 (Min.) = B
Autumn (IX, X, XI) 6.8
Winter (XII, I, II) 5.9

Mean Seasonal Number.. 6.2 ...... = C

$D = A - B = 2.4$ $\qquad$ $E = \dfrac{D}{C} = \dfrac{1}{2.6} = 39\%$

$d = a - b = 2.0$ $\qquad$ $e = \dfrac{d}{c} = \dfrac{1}{.1} = 95\%$

Warmer Months (IV–IX)...... 12.6

Colder Months (X–III).... ...12.3

TABLE II (*B, 1*).

MONTHLY EARTHQUAKE NUMBERS AT *NEMURO*.

Jan. 1885--Dec. 1893.

Instrumentally observed since Aug. 1886.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1885	0	0	3	1	1	4	5	1	4	7	6	1	33
1886	2	5	4	3	3	3	2	4	4	5	2	6	43
1887	2	2	0	2	7	2	5	5	1	1	3	3	33
1888	0	3	4	0	1	2	1	2	1	2	1	1	18
1889	6	3	1	3	7	2	7	3	6	3	3	4	48
1890	3	3	3	6	7	6	0	3	4	2	10	7	54
1891	2	3	7	3	2	3	3	3	2	4	2	11	45
1892	5	1	1	2	3	0	2	1	4	5	3	3	30
1893	3	1	2	2	4	12	4	5	5	4	4	2	48
Sum.	23	21	25	22	35	34	29	27	31	33	34	38	352

TABLE II (B, $1'$).

MONTHLY EARTHQUAKE NUMBERS AT *NEMURO*.

March 1894—Dec. 1899.

All instrumentally observed.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1894			292	112	45	39	24	20	23	30	17	12	**614**
1895	11	10	12	16	11	8	10	10	11	10	7	11	**127**
1896	4	3	7	5	7	7	15	9	11	1	6	8	**83**
1897	5	6	7	6	5	9	3	6	2	7	2	4	**62**
1898	4	3	1	3	5	4	1	3	3	9	5	2	**43**
1899	1	4	4	5	6	7	12	1	3	8	7	1	**62**
(A)	25	26	323	147	79	74	65	52	53	65	44	38	**991**
(B)	25	26	31	35	34	35	41	32	30	35	27	26	**377**
(C)	23	21	25	22	35	34	29	27	31	33	34	38	**352**

(A) Sum of the monthly earthquake numbers, during the six **years** between March 1894 and Dec. 1899.

(B) Sum of the monthly earthquake numbers, during the five **years,** between Jan. 1895 and Dec. 1899.

(C) Sum of the monthly earthquake numbers, during the **nine** years, between Jan. 1885 and Dec. 1893.

The following table has been obtained by taking together (B) and (C):—

Months.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
Sum of B and C.	48	47	56	57	69	69	70	59	61	68	61	64	**729**
Mean.	3.4	3.4	4.0	4.1	4.9	4.9	5.0	4.2	4.4	4.9	4.4	4.6	**52.2**

From the above table, we obtain;

Spring (III, IV, V)......13.0
Summer (VI, VII, VIII)..14.1 (Max.) $=A$
Autumn (IX, X. XI)....13.7
Winter (XII, I, II)......11.4 (Min.) $=B$

Mean Seasonal Number..13.0......$=C$

Warmer Months (IV–IX)....27.5 $\quad D=A-B=2.7 \quad E=\dfrac{D}{C}=\dfrac{1}{4.8}=$ **21%**

Colder Months (X–III)......24.7 $\quad d=a-b=1.6 \quad e=\dfrac{d}{c}=\dfrac{1}{2.7}=$ **37%**

TABLE II (*B*; 2).

MONTHLY EARTHQUAKE NUMBERS AT *AKITA*.

Jan. 1883—Dec. 1899.

Instrumentally observed since July 1894.

Month. / Year.	I.	II.	III.	IV	V.	VI.	VII.	VIII	IX	X.	XI.	XII	Sum.
1883	1	0	0	0	0	0	0	0	0	0	0	0	1
1884	0	0	2	1	4	0	0	1	0	0	1	0	9
1885	0	1	0	0	0	1	0	0	0	1	0	0	3
1886	0	1	0	2	2	0	1	0	0	0	0	2	8
1887	1	0	0	1	3	0	1	0	0	0	0	2	8
1888	1	2	0	0	1	0	0	0	0	0	1	0	5
1889	1	0	0	0	0	1	0	0	0	2	0	0	4
1890	0	1	0	0	0	1	0	0	0	0	4	1	7
1891	0	1	0	1	0	0	0	0	0	0	0	0	2
1892	0	0	0	0	0	0	1	0	7	0	0	1	3
1893	1	0	1	0	1	1	0	1	0	0	0	0	5
1894	0	2	2	1	0	1	0	1	0	7	3	2	19
1895	2	0	0	1	1	1	3	1	0	0	0	1	10
1896	1	0	0	2	1	10	2	*67	*102	9	3	0	197
1897	0	5	2	1	2	2	5	14	4	1	1	3	40
1898	3	0	2	5	1	0	4	3	0	1	1	0	20
1899	1	3	2	1	2	4	7	2	3	4	2	1	32
Sum.	12	16	11	16	18	22	24	90	110	25	16	13	373
Mean.	0.71	0.91	0.65	0.94	1.06	1.29	1.41	1.44	0.50	1.47	0.94	0.76	12.11

Spring (III, IV, V) 2.65
Summer (VI, VII VIII)...4.14 (Max.) $= A$
Autumn (IX, X, XI)......2.91
Winter (XII, I, II)......2.41 (Min.) $= B$

Mean Seasonal Number...3.03 $= C$

Warmer Months (IV–IX)....6.64 $D = A - B = 1.73$ $E = \frac{D}{C} = \frac{1}{1.75} = 57\%$

Colder Months (X–III)......5.47 $d = a - l = 0.97$ $e = \frac{d}{c} = \frac{1}{1.04} = 96\%$

TABLE II (B, 38).

MONTHLY EARTHQUAKE NUMBERS AT *YAMAGATA.*

Dec. 1889—Dec. 1899.

Instrumentally observed since Sep. 1894.

Year. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1889												1	**1**
1890	0	0	0	1	1	1	0	0	0	0	0	0	**3**
1891	0	0	1	4	5	0	3	0	0	0	0	0	**13**
1892	0	3	0	0	0	0	1	0	0	0	0	0	**4**
1893	0	0	0	0	0	0	0	0	0	0	0	6	**6**
1894	2	1	1	0	0	0	0	1	0	5	0	0	**10**
1895	1	0	0	0	2	2	0	0	2	0	0	0	**7**
1896	5	1	1	7	7	15	7	11	8	0	1	1	**64**
1897	1	5	3	0	9	5	5	16	1	1	0	5	**51**
1898	4	1	1	5	4	3	4	2	2	0	0	2	**28**
1899	0	3	2	2	1	0	0	2	0	0	0	0	**10**
Sum.	13	14	9	19	29	26	20	32	13	6	1	15	**197**
Mean.	1.3	1.4	0.9	1.9	3.0	2.6	2.0	3.2	1.3	0.6	0.1	1.4	**19.7**

Spring (III, IV, V)......5.8
Summer (VI, VII, VIII) ..7.8 (Max.) $=A$
Autumn (IX, X, XI)......2.0 (Min.) $=B$
Winter (XII, I, II)......4.1

Mean Seasonal Number...4.9 ......$=C$

$$D=A-B=5.8 \qquad E=\frac{D}{C}=\frac{1}{0.84}=118\%$$

$$d=a-b=3.1 \qquad e=\frac{d}{c}=\frac{1}{0.52}=194\%.$$

Warmer Months (IV–IX)......14.0
Colder Months (X–III)........ 5.7

TABLE II (*B, 4*).

MONTHLY EARTHQUAKE NUMBERS AT *MIYAKO.*

March 1883—Dec. 1899.

Instrumentally observed since June 1896.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1883			1	1	1	0	1	1	1	1	2	0	9
1884	1	0	0	0	3	2	0	2	0	0	0	1	9
1885	0	0	0	1	0	2	0	0	0	2	0	2	7
1886	1	1	0	2	2	1	1	1	0	0	0	1	10
1887	2	0	1	0	1	0	1	0	1	0	0	0	6
1888	0	3	0	1	1	0	1	1	0	0	0	2	9
1889	2	1	2	0	1	4	2	0	0	4	2	2	20
1890	0	0	0	1	0	2	0	0	2	1	2	1	9
1891	0	0	1	4	4	3	0	1	0	3	1	3	20
1892	1	1	0	1	2	1	3	1	0	2	0	0	12
1893	1	0	0	0	1	4	5	1	4	2	1	2	21
1894	0	2	7	2	1	1	3	1	2	5	5	3	32
1895	4	1	3	2	3	4	4	2	3	2	1	3	32
1896	5	4	1	16	1	*59	24	34	*28	7	9	1	189
1897	6	*42	8	7	8	12	9	*42	7	12	12	12	177
1898	7	4	11	11	7	5	8	12	4	2	3	2	76
1899	2	4	9	6	2	6	5	7	3	9	11	2	66
Sum.	32	63	44	55	38	106	67	106	55	52	49	37	704
Mean.	2.0	1.4	2.6	3.2	2.2	2.9	3.9	4.0	1.7	3.1	2.9	2.2	32.1

Spring (III, IV, V)........8.0
Summer (VI, VII, VIII)..10.8 (Max.) $= A$
Autumn (IX, X, XI)......7.7
Winter (XII, I, II).......5.6 (Min.) $= B$

Mean Seasonal Number...8.0 ..... $= C$

$D = A - B = 5.2$ $\qquad E = \dfrac{D}{C} = \dfrac{1}{1.5} = 65\%$

$d = a - b = 2.6$ $\qquad e = \dfrac{d}{c} = \dfrac{1}{1.0} = 96\%$

Warmer Months (IV–IX)......17.9

Colder Months (X–III).......14.2

TABLE II (*B*, *5*).

MONTHLY EARTHQUAKE NUMBERS AT *ISHINOMAKI*.

Jan. 1886—Dec. 1899.

Instrumentally observed since 1891.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1886	3	1	1	2	2	0	1	0	1	0	1	4	**16**
1887	3	3	1	3	5	0	2	1	0	0	0	0	**18**
1888	0	4	0	2	3	0	1	2	0	1	2	4	**19**
1889	2	2	1	0	0	1	1	2	0	4	1	4	**18**
1890	1	1	1	2	1	3	0	1	1	4	8	3	**26**
1891	0	1	3	7	7	4	5	3	5	10	24	13	**82**
1892	10	9	5	9	3	4	12	9	3	6	3	2	**75**
1893	1	0	5	4	7	33	24	14	22	12	25	9	**156**
1894	2	2	5	2	6	6	27	25	27	15	15	7	**139**
1895	2	4	4	11	6	6	3	2	3	1	2	3	**50**
1896	1	1	0	1	1	4	12	12	18	11	11	1	**73**
1897	4	17	12	11	19	6	14	49	7	13	12	10	**174**
1898	11	3	9	15	21	7	14	8	11	5	6	7	**117**
1899	2	11	7	12	4	3	3	8	10	5	3	3	**71**
Sum.	42	59	54	84	85	77	119	136	108	87	113	70	**1034**
Mean.	3.0	4.2	3.9	6.0	6.0	5.5	8.5	9.7	7.7	6.2	8.1	5.0	**73.8**

Spring (III, IV, V)......15.9
Summer (VI, VII, VIII)..23.7 (Max.) $= A$
Autumn (IX, X, XI) 22.0
Winter (XII, I, II)......12.2 (Min.) $= B$

Mean Seasonal Number..18.4 ...... $= C$

$$D = A - B = 11.5 \qquad E = \frac{D}{C} = \frac{1}{1.6} = 62\%$$

$$d = a - b = 6.7 \qquad e = \frac{d}{c} = \frac{1}{0.93} = 110\%$$

Warmer Months (IV–IX)....43.4
Colder Months (X–III)......30.4

TABLE II (*B, 6*).

MONTHLY EARTHQUAKE NUMBERS AT *FUKUSHIMA*.

May 1889—Dec. 1899.

Instrumentally observed since March 27th 1895.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1889					1	2	0	2	1	3	8	5	22
1890	2	2	2	6	5	2	1	0	3	3	4	2	32
1891	0	2	1	2	3	2	4	1	2	1	3	1	22
1892	2	4	0	4	1	2	5	1	0	0	1	2	22
1893	2	1	2	2	9	16	7	4	2	1	1	2	49
1894	1	2	9	5	2	3	3	3	2	9	5	3	47
1895	6	1	4	9	2	10	9	6	8	6	3	4	68
1896	22	13	12	40	9	39	22	20	21	7	7	5	217
1897	9	27	13	6	8	3	15	41	6	11	13	19	174
1898	8	3	13	18	7	7	7	3	6	0	4	3	79
1899	0	5	11	13	19	5	4	12	10	17	23	26	125
Sum.	52	60	67	105	66	91	77	93	64	58	72	52	857
Mean.	5.2	6.0	6.7	10.5	6.0	8.3	7.0	8.5	5.8	5.3	6.5	4.7	80.5

Spring (III, IV, V)...... .23.2
Summer (VI, VII, VIII) . .23.8 (Max.) = A
Autumn (IX, X, XI)........17.6
Winter (XII, I, II) ...... .15.9 (Min.) = B

Mean Seasonal Number ...20.1...... = C

$$D = A - B = 7.9 \qquad E = \frac{D}{C} = \frac{1}{2.6} = 39\%$$

$$d = a - b = 5.8 \qquad e = \frac{d}{c} = \frac{1}{1.2} = 83\%$$

Warmer Months (IV-IX)..46.1

Colder Months (X-III)....34.4

TABLE II (*B*, 7).

MONTHLY EARTHQUAKE NUMBERS AT *UTSUNOMIYA*.

Jan. 1894--Dec. 1899.

Instrumentally observed since July 1895.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1891	0	4	1	3	4	3	2	2	1	6	3	3	**32**
1892	5	6	1	4	0	4	2	0	2	4	3	2	**33**
1892	4	1	2	5	2	5	1	1	2	0	1	2	**26**
1894	2	4	2	4	0	4	5	3	3	3	10	3	**43**
1895	14	3	4	7	4	7	7	3	2	10	2	3	**66**
1896	10	10	5	2	6	9	4	11	1	1	0	3	**62**
1897	5	6	3	3	15	4	5	16	9	9	4	11	**90**
1898	5	3	6	9	3	9	14	6	6	8	8	8	**85**
1899	4	3	9	7	5	1	6	8	2	6	3	1	**55**
Sum.	49	40	33	44	39	46	46	50	28	47	34	36	**492**
Mean.	5.4	4.4	3.7	4.9	4.3	5.1	5.1	5.6	3.1	5.2	3.8	4.0	**54.6**

Spring (III, IV, V)......12.9
Summer (VI, VII, VIII)..15.8 (Max.) = *A*.
Autumn (IX, X, XI)....12.1 (Min.) = *B*.
Winter (XII, I, II) 13.8

Mean Seasonal Number..13.7...... = *C*.

$D = A - B = 3.7 \qquad E = \frac{D}{C} = \frac{1}{3.7} = 27\%$

$d = a - b = 2.5 \qquad e = \frac{d}{c} = \frac{1}{1.8} = 55\%$

Warmer Months (IV–IX)..28.1
Colder Months (X–III)....26.5

TABLE II (*B*, *8*).

MONTHLY EARTHQUAKE NUMBERS AT *MAEBASHI*.

Dec. 1896—Dec. 1899.

All instrumentally observed.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1896												2	2
1897	2	5	3	0	4	1	3	4	1	5	1	2	31
1898	1	1	3	2	2	5	7	5	9	5	6	4	50
1899	2	2	11	6	1	0	3	5	0	2	6	5	43
Sum.	5	8	17	8	7	6	13	14	10	12	13	13	126
Mean.	1.7	2.7	5.7	2.7	2.3	2.0	4.3	4.7	3.3	4.0	4.3	3.3	41.0

Spring (III, IV, V)...... 10.7
Summer (VI, VII, VIII) .. 11.0
Autumn (IX, X, XI) .... .11.6 (Max.) = A
Winter (XII, I, II) .... 7.7 (Min.) = B

Mean Seasonal Number.. 10.3.. ... = C

$$D = A - B = 3.9 \qquad E = \frac{D}{C} = \frac{1}{26.4} = 38\%$$

$$d = a - b = 4.0 \qquad e = \frac{d}{c} = \frac{1}{0.85} = 118\%$$

Warmer Months (IV-IX)......19.3

Colder Months (X-III)......21.7

TABLE II (*B, 9*)

MONTHLY EARTHQUKE NUMBERS AT *HIKONE.*

Jan. 1894—Dec. 1899.

All instrumentally observed.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1894	*20	6	3	0	2	7	8	9	1	4	3	6	**69**
1895	11	1	2	6	2	1	5	1	7	7	2	6	**51**
1896	4	1	2	10	6	13	9	8	1	1	1	2	**58**
1897	3	3	4	7	3	1	0	6	1	2	1	0	**31**
1898	1	0	0	2	0	0	0	4	0	1	2	0	**10**
1899	3	2	6	2	5	2	1	0	0	0	4	1	**26**
Sum.	42	13	17	27	18	24	23	28	10	15	13	15	245
Mean.	4.4	2.2	2.8	4.5	3.0	4.0	3.8	4.7	1.7	2.5	2.2	2.5	38.3

Spring (III, IV, V) 10 3
Summer (VI, VII, VIII) . . .12.5 (Max.)$=A$
Autumn (XI. X, XI) . . . 6.4 (Min.)$=B$
Winter (XII, I, II) 9.1

Mean Seasonal Number . . . . 9.6 . . . . . . $=C$

$$D=A-B=6.1 \qquad E=\frac{D}{C}=\frac{1}{1.57}=64\%$$

$$d=a-b=3.0 \qquad e=\frac{d}{c}=\frac{1}{1.07}=94\%$$

Warmer Months (IV-IX) . . .21.7
Colder Months (X-III) 16.6

TABLE II (*B*, *10*).

MONTHLY EARTHQUAKE NUMBERS AT *KOCHI*.

Jan. 1883—Dec. 1899.

Instrumentally observed since Dec. 1893.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
1883	0	1	0	1	0	1	0	0	2	0	0	0	5
1884	0	0	0	0	2	1	0	2	0	0	0	2	7
1885	0	0	0	0	0	1	0	0	0	0	0	0	1
1886	0	0	0	0	0	0	0	0	0	0	0	0	0
1887	1	0	0	1	0	0	0	1	0	1	1	0	5
1888	1	0	1	0	0	1	0	0	0	0	0	1	4
1889	0	1	2	0	0	0	2	0	0	0	0	0	5
1890	0	0	0	0	0	0	0	0	0	0	0	0	0
1891	0	0	0	0	0	0	2	1	0	1	0	0	4
1892	0	0	0	0	1	0	0	0	0	0	0	0	1
1893	0	1	0	0	0	0	0	0	0	0	0	3	4
1894	2	3	0	0	0	1	0	2	0	0	0	0	8
1895	0	0	0	0	0	1	0	0	0	1	1	0	3
1896	0	2	1	1	0	0	0	0	0	1	0	0	5
1897	1	1	1	4	0	0	1	0	2	0	1	0	11
1898	0	0	1	1	0	1	1	0	1	1	2	3	11
1899	1	1	2	0	1	2	1	0	0	2	2	0	12
Sum.	6	10	8	8	4	9	7	6	5	7	7	9	89
Mean.	0.35	0.59	0.47	0.47	0.24	0.53	0.41	0.35	0.29	0.41	0.41	0.53	5.05

Spring (III, IV, V)........1.18
Summer (VI, VII, VIII)...1.29
Autumn (IX, X, XI)......1.11 (Min.)$=B$
Winter (XII, I, II)........1.47 (Max.)$=A$

Mean Seasonal Number....1.26 ......$=C$

$$D=A-B=0.36 \qquad E=\frac{D}{C}=\frac{1}{3.5}=29\%$$

$$d=a-b=0.35 \qquad e=\frac{d}{c}=\frac{1}{1.2}=83\%$$

Warmer Months (IV-IX)....2.29

Colder Months (X-III)....2.76

TABLE II (*B, II*).

MONTHLY EARTHQUAKE NUMBERS AT *HAMADA*.

Jan. 1893—Dec. 1894.

Instrumentally observed since July 1894.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	**Sum.**
1893	0	2	0	0	0	0	0	0	0	1	0	0	**3**
1894	0	0	0	0	0	1	0	0	1	0	0	0	**2**
1895	0	0	0	0	0	0	0	1	0	2	1	0	**4**
1896	0	0	0	0	0	0	0	0	1	0	0	0	**1**
1897	2	0	1	0	0	0	0	1	1	0	1	1	**7**
1898	0	0	0	1	1	0	0	2	0	1	0	2	**7**
1899	0	0	1	0	0	0	1	0	0	2	1	1	**6**
Sum.	2	2	2	1	1	1	1	4	3	6	3	4	30
Mean.	0.29	0.29	0.29	0.14	0.14	0.14	0.14	0.57	0.43	0.86	0.43	0.57	4.29

Spring (III, IV, V) . . . . . . 0.57 (Min.) $= B$
Summer (VI, VII, VIII). 0.85
Autumn (IX, X, XI) . . . . 1.72 (Max.) $= A$
Winter (XII, I, II) 1.15

Mean Seasonal Number . . 1.07 . . . . . . $= C$

$D = A - B = 1.15$ $\qquad E = \frac{D}{C} = \frac{1}{0.93} = 107\%$

$d = a - b = 0.72$ $\qquad e = \frac{d}{c} = \frac{1}{0.50} = 200\%$

Warmer Months (IV-IX) . . . 1.56
Colder Months (X III) 2.73

7. *Annual variation of seismic frequency.* Figs. 4(1–5) and 5(1–3) illustrate graphically the variation of seasonal seismic frequency at the different stations.

Comparing Figs 4 and (5) with each other we see that the different stations may, according to the character of the annual variation, be divided into two nearly opposite groups (A) and (B), as follows :—

> The annual variation of seismic frequency at stations belonging to Group (A) indicates its seasonal maximum in Spring (in a few cases, in Winter), and its minimum in Summer or Autumn (in a few cases, in Winter); while that at stations belonging to Group (B) indicates its seasonal maximum in Summer (in one case, in Autumn), and its minimum in Winter or Autumn.

The (A) Group stations are *Tokyo, Niigata, Nagano, Numazu, Hamamatsu, Nagoya, Gifu, Tsu, Wakayama, Hiroshima, Kumamoto,* and *Kagoshima.* The annual variation at *Sapporo, Hakodate* and *Oita* is somewhat different from that at the above named stations; but, on account of the occurrence of the maximum in Summer, I have classed these three places under Group (A).

The (B) Group stations are *Nemuro, Akita, Yamagata, Miyako, Ishinomaki, Fukushima, Utsunomiya, Maebashi, Hikone, Hamada* and *Kochi.*

The division of the various meteorological observatories into two groups of (A) and (B) as given in Table I is based on the classification defined above. The same division is used in other tables relating to the annual seismic variation.

8. *Amount of the annual seismic variation.* Table III gives for the different stations the amount of fluctuation of the monthly and seasonal seismic frequencies, e and E. The symbol S denotes the total number of earthquakes observed at a given station which has been utilized in the calculation of the quantities c, d, e, C, D, E.

The results contained in Table III may be summarized as follows. (Herely *Hamada, Hamamatsu* and *Kochi* are excluded, as the number of earthquakes observed at each of these three stations is few and less than

100. Further, *Niigata* is also excluded, as the number of earthquakes observed in April 1891 at this station is 29, which is far greater than its usual monthly frequency.)

Group (*A*). In the monthly seismic frequency, *e* varies between 34 and 155% and has a mean value of 89%. In the seasonal seismic frequency, *E* varies between 25 and 86% and has a mean value of 48%.

Group (*B*). In the monthly seismic frequency, *e* varies between 37 and 194% and has a mean value of 93%. In the seasonal seismic frequency, *E* varies between 21 and 118% and has a mean value of 52%.

It is to be noted that the above *mean* values of the fluctuations have been calculated by supposing the *weight* of the quantities *e* and *E* for the stations, whose *S* is above 500, to be double that of the corresponding quantities for the stations, whose *S* is below 500. Similar method has been adopted in deducing certain other mean values given below.

From the above it will be seen that the amount of fluctuation of the seismic frequency is on the whole nearly same for the stations of Group (*A*) as for the stations of Group (*B*); the mean values of *e* and *E* being, for each Group, respectively about 90 and 50%. The months and seasons, in which the maximum and minimum frequencies occur, are, however, nearly opposite in the two groups.

9. *Distribution of earthquakes in warmer and colder months.* Table IV gives for each of the stations the mean seismic frequency for the warmer and colder months; the two divisions of the year being defined as follows.—

Warmer months=April to September. The seismic frequency for these months is obtained by summing the frequencies for the six months, April to September.

Colder months=October to March. The seismic frequency for these months is obtained by summing the frequencies for the six months, October to March.

TABLE III.

ANNUAL VARIATION OF SEISMIC FREQUENCY.

N = Number of earthquakes utilized in the deduction of the quantities c, d, etc.

c = Mean monthly eqke number.

$d = \left\{\begin{array}{l}\text{Difference between the max. and min.}\\ \text{monthly eqke numbers.}\end{array}\right.$

$e = \frac{d}{c} = \left\{\begin{array}{l}\text{Annual fluctuation of the monthly}\\ \text{seismic frequency, in \%.}\end{array}\right.$

C = Mean seasonal eqke number.

$D = \left\{\begin{array}{l}\text{Difference between the max. and min.}\\ \text{seasonal eqke numbers.}\end{array}\right.$

$E = \frac{D}{C} = \left\{\begin{array}{l}\text{Annual fluctuation of the seasonal seismic}\\ \text{frequency, in \%.}\end{array}\right.$

Station.	Monthly distribution.			Seasonal distribution.			N	Remark.
	c	d	e %	C	D	E %		
(*A*)								
Sapporo	0.56	0.62	111	1.67	0.83	50	156	Majority instrumentally recorded.
Hakodate	0.94	0.71	76	2.82	0.96	34	305	Do.
Tokyo	7.2	3.3	46	21.7	7.2	33	2056	All instrumentally recorded.
Niigata*	1.30	2.64	203	3.90	3.79	97	216	Majority " "
Nagano	2.4	3.5	146	7.2	6.1	85	310	All " "
Numazu	0.9	1.0	111	2.6	1.4	54	154	All non-instrumentally recorded.
Hamamatsu*	0.45	1.0	222	1.33	1.4	105	99	Do.
Nagoya	7.2	7.3	101	21.7	11.5	53	520	All instrumentally recorded.
Gifu	1.25	12.6	101	37.4	21.9	59	898	Do.
Tsu	1.1	1.7	155	3.4	1.7	50	133	Nearly all instrumentally recorded.
Wakayama	1.6	1.1	67	4.9	2.0	10	406	Majority instrumentally recorded.
Hiroshima	0.58	0.5	34	1.75	0.6	86	107	Partly instrumentally recorded.
Ōita	1.7	1.5	88	5.1	1.3	25	264	Nearly all instrumentally recorded.
Kumamoto	6.3	4.5	71	18.8	5.9	31	696	Do.
Kagoshima	2.1	2.0	95	6.2	2.4	39	365	Do.
Mean	3.28	4.0	89	13.81	6.49	48	—	
(*B*)								
Nemuro	4.3	1.6	37	13.0	2.7	21	729	All instrumentally recorded.
Akita	1.01	0.97	96	3.03	1.73	57	204	Majority " "
Yamagata	1.6	3.1	194	4.9	5.8	118	194	Do.
Miyako	2.7	2.6	96	8.0	5.2	65	533	Do.
Ishinomaki	6.1	6.7	110	18.4	11.5	62	1034	Majority non-instrumentally recorded.
Fukushima	6.7	5.8	83	20.1	7.9	39	857	Partly instrumentally recorded.
Utsunomiya	4.6	2.5	55	13.7	3.7	27	492	Majority instrumentally recorded.
Maebashi	3.4	4.0	118	10.3	3.9	38	126	All instrumentally recorded.
Hikone	3.2	3.0	94	9.6	6.1	64	225	Do.
Hamada*	0.36	0.72	200	1.07	1.15	107	30	Partly instrumentally recorded.
Kochi*	0.42	0.35	83	1.26	0.36	29	86	Do.
Mean	4.11	3.61	93	12.35	9.57	52	—	

The four stations marked with *asterisks* have not been taken into account in the deduction of the *means*.

TABLE IV.

DISTRIBUTION OF THE EARTHQUAKES INTO THE WARMER AND COLDER MONTHS OF THE YEAR.

(A)

Station.	Warmer Months.	Colder Months.	Ratio, $\frac{Warmer}{Colder}$
Sapporo	2.84	3.83	1.35
Hakodate	5.00	6.30	1.26
Tokyo	45.1	41.7	0.92
Niigata*	10.21	5.41	0.53
Nagano	12.5	16.3	1.30
Numazu	4.6	5.8	1.26
Hamamatsu	1.74	3.57	2.05
Nagoya	42.2	44.5	1.05
Gifu	71.8	77.8	1.08
Tsu	5.1	8.4	1.65
Wakayama	10.8	9.1	0.84
Hiroshima	3.1	3.9	1.26
Ōita	8.8	11.7	1.33
Kumamoto	37.1	37.9	1.02
Kagoshima	12.6	12.3	0.98
Mean			1.14

(B)

Station.	Warmer Months.	Colder Months.	Ratio, $\frac{Warmer}{Colder}$
Nemuro	27.5	24.7	1.11
Akita	6.64	5.47	1.21
Yamagata	14.0	5.7	2.46
Miyako	17.9	14.2	1.26
Ishinomaki	43.4	30.4	1.43
Fukushima	46.1	34.4	1.34
Utsunomiya	28.1	26.5	1.06
Maebashi	19.3	21.7	0.89
Hikone	21.7	16.6	0.31
Hamada*	1.56	2.73	0.57
Kōchi*	2.29	2.76	0.83
Mean			1.32

* The three stations marked with *asterisks* have not been taken into account in the calculation of the mean ratios.

TABLE V.

MONTHS AND SEASONS OF THE MAXIMUM AND MINIMUM SEISMIC FREQUENCIES.

(A)

Station.	Max.	Min.	Max.	Min.
Sapporo	October	January	Autumn	Summer
Hakodate	,,	September	,,	,,
Tokyo	May	,,	Spring	Autumn
Niigata	April	December	,,	Winter
Nagano	May	August	,,	Summer
Numazu	January	,,	,,	,,
Hamamatsu	November	July	Winter	,,
Nagoya	January	November	Spring	Autumn
Gifu	April	August	,,	Summer
Tsu	January	July	,,	Autumn
Wakayama	May	February, December	,,	Winter
Hiroshima	January	June	Winter	Summer
Oita	November	May	Autumn	,,
Kumamoto	January	July	Spring	,,
Kagoshima	April	,,	,,	,,
Seasonal distribution of Max. and Min.			Sp. 10. A. 3. W. 2.	Su. 10. A. 3. W. 2.

(B)

Station.	Max.	Min.	Max.	Min.
Nemuro	May, June, July	January, February	Summer	Winter
Akita	October	September	,,	,,
Yamagata	August	November	,,	Autumn
Miyako	July	February	,,	Winter
Ishinomaki	August	January	,,	,,
Fukushima	April	December	,,	,,
Utsunomiya	August	September	,,	Autumn
Maebashi	March	January	Autumn	Winter
Hikone	August	September	Summer	Autumn
Hamada	October	April, May, June, July	Autumn	Spring
Kōchi	February	May	Winter	Autumn
Seasonal distribution of Max. and Min.			Su. 8. A. 2. W. 1.	W. 6. A. 4. Sp. 1.

According to Table IV, the seismic frequency for the stations of Group (A) is greater in the mean ratio of 1,14 : 1 in the colder than in the warmer months; while for the stations of Group (B), it is greater in the mean ratio of 1,23 : 1 in the warmer than in the colder months.

10. *Months and seasons in which maximum and minimum seismic frequencies take place.* Table V gives for the different stations the months and seasons in which maximum and minimum seismic frequencies have taken place.

The results contained in Table V may be summarized as follows.—With respect to the monthly seismic distribution the months of the maximum and minimum frequencies are widely different for the stations of the two groups. With respect to the seasonal distribution, however, the result is more uniform. Thus, of the 15 stations of Group (A), 10 showed the maximum seasonal frequency in Spring and also 10 the minimum in Summer; while, of the 11 stations of Group (B), 8 showed the maximum in Summer and 6 the minimum in Winter.

11. *Kyoto earthquakes.* The seismic activity at Kyoto has been small in recent years, the mean annual frequency being only about 5. During historical times, however, there were epochs of marked seismic activity. In fact the number of earthquakes at Kyoto, so far as recorded in histories, chronicles, manuscripts, etc., amounts for the time interval of 1070 years, between its foundation in 797 and the transfer of the Imperial residence to Tokyo in 1868, to 34 *destructive*, 194 *strong* and 1090 *small* earthquakes, making up a sum total of 1318. The monthly and seasonal distributions of these earthquakes are given in the following tables. (For a detailed discussion on the historical Kyoto earthquakes, see *the Earthquake Investigation Committee Catalogue of Japanese Earthquakes* and *Notes* upon it, Jour. Sc. Coll., Imp. Univ., Tokyo, Vol. XI.).

TABLE VI.

1318 EARTHQUAKES RECORDED AT KYOTO, BETWEEN 797 AND 1868.

(1.) Monthly Distribution.

January.	95
February.	95
March.	132
April.	116
May.	113
June.	107
July.	107
August.	124
September.	87
October.	104
November.	117
December.	119

(2.) Seasonal Distribution.

Spring (III, IV, V.)	361
Summer (VI, VII, VIII.)	338
Autumn (IX, X, XI.)	308
Winter (XII, I, II.)	309

The annual seismic variation at Kyoto, given in the above tables, is graphically illustrated in Fig. 6. The maximum frequency occurred in Spring and the minimum in Autumn and Winter; Kyoto is therefore to be regarded as belonging to Group (A).

12. *Relation between the annual seismic variation and the geographical position.* As already stated in foregoing §§, the annual seismic variation at the stations of Group (A) is almost the reverse of that at the stations of Group (B). To see the relation between the annual seismic variation and the geographical position of the varions stations, I have drawn the map (Fig. 7), where the regions belonging to Group (A) are coloured *red* and those belonging to Group (B) are coloured *blue*. (Some portions of the Empire such as the southern part of Kii are left uncoloured, as indication of the want of a perfectly accurate seismic observation.

Fig. 7 shows that the region belonging to Group (A) is separated by definite boundary lines from that belonging to Group (B). Thus the (B) Group region includes the whole north-eastern part of Japan, that is to say, the eastern half of Hokkaido, the San-Riku provinces (Mutsu, Rikuchu and Rikuzen), the Ryō-U provinces (Uzen and Ugo), Iwaki, Iwashiro, Hitachi, Shimotsuke, the northern part of Echigo, a greater portion of Kotsuke, the northern part of Musashi and a greater portion of Shimosa. The vicinity of Hikone (bordering the Lake Biwa) and of Hamada, and the southern part of the Island of Shikoku also belong to the (B) Group region. The (A) Group region includes the western half of Hokkaido and the whole of Japan to the west of Echigo, Musashi and the Awa-Kazusa Peninsula, with the exception of a few isolated portions which belong to the (A) Group region, as already mentioned.

In seeking a possible explanation of this peculiar geographical relation of the annual seismic variation, it is to be noted that the principal boundary line, (*a b c d*), between the two regions is very similar to an isoseismal line or the boundary line of the shaken area of strong earthquakes originating off the south-eastern coast of Hokkaido or the eastern coast of the San-Riku provinces. (See Omori and Hirata's paper: *Earthquake measurement at Miyako*, Jour. Sc. Coll., Imp. Univ., Tokyo,

Vol. XI.) From this fact we may suppose that there exists a close relation between the annual seismic variation at a given place and the origins of the earthquakes which are felt at the latter. In fact, speaking generally, we see that the majority of the earthquakes which affect the north-eastern part of Japan originate under the Pacific. For instance, Fukushima is an inland station, it is nevertheless very sensitive to earthquakes originating off the coast of the San-Riku provinces. On the other hand, the majority of the earthquakes affecting the western part of Japan have inland origin. Amongst others, Nagano, Gifu, Nagoya, Kumamoto and Kagoshima are striking examples of the districts disturbed by so many small inland local shocks. The vicinity of Hamada and the southern portion of Shikoku, which are enclosed within the (*A*) group region, belong to (*B*) group, probably as they are affected mostly by earthquakes of submarine origin. The only apparent exception to the general rule is Hikone, which belongs to Group (*B*), but is shaken mostly by earthquakes of inland origin; it may be, however, that the Lake Biwa exercises an ocean like influence on the annual seismic frequency at Hikone. On the whole, therefore, we may state :—

(1) The (*A*) region is shaken mostly by earthquakes of inland origin;

(2) The (*B*) region is, on the contrary, shaken mostly by earthquakes of submarine origin.

Let us next consider the agency which produces the annual seismic variation. The principal factor seems here to be the atmospheric pressure, which is an external force acting on the earth's crust and produces certain effects on the strains existing in the interior or at the surface of the latter. Further it may be supposed that, in general, a high barometric pressure is accompanied by a high seismic frequency and a low barometric pressure by a low seismic frequency. Now, since the barometric pressure on land is minimum in Summer and maximum in Winter, it looks very natural that the (*A*) region, affected mostly by earthquakes of inland origin, should present the maximum seismic frequency in Summer (or Autumn) and the minimum in Winter (or

Spring). On the other hand, the sea bottom may be subject to but a slight degree of the effect of the annual variation of barometric pressure, or may even be subject to a greater total pressure in Summer than in Winter; consequently it may be that the (*B*) region tends, in contrast to the neighbouring (*A*) region, to show a greater seismic frequency in Summer than in Winter. The annual variation of atmospheric pressure, so far as it relates to our question, is discussed more fully in the next §.

13. *Annual variation of barometric pressure in the Northern Pacific.* With respect to the barometric pressure *on* an ocean, it is, in the first place, to be noticed, as was pointed out by Dr. Charles Davison,* that the pressure at the sea bottom may not necessarily follow the barometric pressure on the surface of the water in its annual fluctuation. Supposing, for instance, that the barometric pressure has increased by a certain amount, the sea water would be depressed by a proper amount and adjust itself so as to keep the surface in equilibrium; similarly in the case of a decrease of the barometric pressure, the sea water may rise by a proper amount to regain its equilibrium. Consequently the actual total pressure at the sea bottom may not necessarily much vary during the year.

The second point to be noted in connection with our problem is the distribution of the atmospheric pressure in the Northern Pacific, where the barometer is much higher in Summer than in Winter. Thus according to *Stiller Ocean*†, othere is in January and February an elliptical area of low barometric pressure (minimum pressure = 752,5 mm), whose major axis runs nearly parallel E W and which, with its centre at about the Aleutian Islands, extends from the south-west coast of Alasca to the south of the Kamtschakka peninsula. On the contrary, there is in July and August an irregular elliptical area of high barometric pressure (maximum pressure = 770 mm), whose major axis is nearly parallel to the latitude lines, its centre being at about long. 152°½ *E* and lat. 37°½ *N*. These distributions of the barometric pressure is graphically shown in Fig. 8, in

* Dr. Charles Davison: Philosophical Transactions of the Royal Society of London, Vol. 184.

† Published by *Seewarte*, Hamburg.

which x is the distance measured towards East from an arbitrarily chosen point in the western coast of the Main Island at lat. 40° (vicinity of Akita), and y is the corresponding barometric pressure. (The full curve refers to January and February, while the dotted curve refers to July and August.) According to this figure, it will be seen that, immediately off the eastern coast of the San-Riku provinces the barometric pressure is indeed higher in Winter than in Summer. From about 800 Km off the coast, however, the barometric pressure is higher in Summer than in Winter. To get an idea of the relative barometric heights in the two seasons, we may, for instance, confine our attention to the region between long. 140° E and long. 180° E (Fig. 8); the average atmospheric pressures along the latter is 760,5 mm for July and August and 756,0 mm for January and February.

On these considerations are based the statements given at the end of § 12.

14. *Comparison of the annual variation of seismic frequency with that of barometric pressure.* Tables VI, VII and VIII contain the data necessary for comparing the annual variation of seismic frequency with that of barometric pressure for the different stations:—

Table VI has been constructed from Table II and gives the monthly and seasonal seismic frequencies;

Table VII gives the mean monthly and seasonal barometric pressures;

Table VIII gives the seasonal seismic frequencies expressed in percentages, the annual seismic frequency being, for each station, taken as 100%.

TABLE VI.

MEAN MONTHLY AND SEASONAL EARTHQUAKE NUMBERS AT THE DIFFERENT STATIONS.

Station. \ Month.	I	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Mean (Monthly)	Spring.	Summer.	Autumn.	Winter.	Mean (seasonal)
(*A*)																		
Sapporo	0.26	0.87	0.61	0.74	0.26	0.48	0.30	0.52	0.54	0.88	0.71	0.50	0.56	1.61	1.30	2.13	1.63	1.67
Hakodate	0.74	1.07	0.93	1.00	0.85	0.92	0.78	0.74	0.70	1.41	1.30	0.85	0.94	2.78	2.45	3.41	2.66	2.82
Tokyo	8.1	8.0	8.3	8.5	8.7	6.6	7.0	5.5	5.4	5.9	7.0	7.8	7.2	25.5	19.1	18.3	23.9	21.7
Niigata	0.92	0.85	0.85	3.07	2.07	2.07	1.07	0.86	1.07	1.43	0.93	0.43	1.30	5.99	4.00	3.43	2.20	3.90
Nagano	2.6	3.1	2.9	2.9	4.1	1.5	1.7	0.9	1.1	3.3	2.4	2.0	2.4	10.2	4.1	6.8	7.7	7.2
Numazu	1.5	1.0	1.4	1.1	0.7	0.8	0.5	0.5	1.0	0.7	0.6	0.6	0.9	3.2	1.8	2.3	3.1	2.6
Hamamatsu	0.80	0.60	0.27	0.67	0.40	0.27	0.07	0.13	0.20	0.36	1.07	0.47	0.44	1.34	0.17	1.63	1.87	1.33
Nagoya	11.5	6.5	11.3	8.3	7.8	5.5	5.2	9.7	5.7	6.0	4.2	5.0	7.2	27.4	20.4	15.9	23.0	21.7
Gifu	16.0	12.3	14.8	20.8	13.8	10.3	9.0	8.2	9.7	12.2	12.8	9.7	12.5	49.4	27.5	34.7	38.0	37.4
Tsu	2.2	0.8	2.1	1.5	0.7	0.6	0.5	1.2	0.6	0.9	1.1	1.3	1.1	4.3	2.3	2.6	4.3	3.4
Wakayama	1.8	1.2	2.0	1.9	2.3	1.6	1.9	1.4	1.7	1.4	1.5	1.2	1.6	6.2	4.9	4.6	4.2	4.9
Hiroshima	0.8	0.7	0.4	0.7	0.6	0.3	0.6	0.5	0.4	0.8	0.8	0.4	0.6	1.7	1.4	2.0	1.9	1.75
Oita	1.8	1.8	1.7	2.2	0.9	1.1	1.1	2.0	1.2	2.2	2.4	1.8	1.7	4.8	1.5	3.8	5.4	5.1
Kumamoto	8.2	7.0	7.4	7.1	7.9	7.2	3.7	5.6	5.6	6.6	4.6	4.1	6.3	22.4	16.5	16.8	19.3	18.8
Kagoshima	1.6	2.4	1.9	3.4	2.0	1.7	1.4	1.8	2.3	2.7	1.8	1.9	2.1	7.3	4.9	6.8	5.9	6.2
Mean	5.65	4.52	5.47	5.99	5.07	3.90	3.33	3.80	3.52	4.28	3.37	3.57	3.86	16.53	11.04	11.74	13.74	13.26
(*B*)																		
Nemuro	3.4	3.4	4.0	4.1	4.9	4.9	5.0	4.2	4.4	4.9	4.4	4.6	4.3	13.0	14.1	13.7	11.4	13.0
Akita	0.71	0.94	0.65	0.91	1.06	1.29	1.41	1.44	0.50	1.47	0.94	0.76	1.01	2.65	4.14	2.91	2.41	3.03
Yamagata	1.3	1.4	0.9	1.9	3.0	2.6	2.0	3.2	1.3	0.6	0.1	1.4	1.6	5.8	7.8	2.0	4.1	4.9
Miyako	2.0	1.4	2.6	3.2	2.2	2.9	3.9	4.0	1.7	3.1	2.9	2.2	2.7	8.0	10.8	7.7	5.6	8.0
Ishinomaki	3.0	4.2	3.9	6.0	6.0	5.5	8.5	9.7	7.7	6.2	8.1	5.0	6.1	15.9	23.7	22.0	12.2	18.4
Fukushima	5.2	6.0	6.7	10.5	6.0	8.3	7.0	8.5	5.8	5.3	6.5	4.7	6.7	23.2	23.8	17.6	15.9	20.1
Utsunomiya	5.4	4.4	3.7	4.9	4.3	5.1	5.1	5.6	3.1	5.2	3.8	4.0	4.6	12.9	15.8	12.1	13.8	13.7
Maebashi	1.7	2.7	5.7	2.7	2.3	2.0	4.3	4.7	3.3	4.0	4.3	3.3	3.4	10.7	11.0	11.6	7.7	10.3
Hikone	4.4	2.2	2.8	4.5	3.0	4.0	3.8	4.7	1.7	2.5	2.2	2.5	3.2	10.3	12.5	6.4	9.1	9.6
Hamada	0.29	0.29	0.29	0.14	0.14	0.14	0.14	0.57	0.43	0.86	0.43	0.57	0.36	0.57	0.85	1.72	1.15	1.07
Kochi	0.35	0.59	0.47	0.47	0.24	0.53	0.41	0.35	0.29	0.41	0.41	0.53	0.42	1.18	1.29	1.11	1.47	1.26
Mean	3.13	3.20	3.70	4.81	3.99	4.48	5.03	5.57	3.78	4.06	4.24	3.46	4.11	12.50	15.08	12.08	9.79	12.35

TABLE VII.

MEAN MONTHLY AND SEASONAL BAROMETRIC PRESSURES AT THE DIFFERENT STATIONS.*

Station. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Year.	Winter.	Spring.	Summer.	Autumn.
(*A*)																	
Sapporo	59.8	60.9	60.0	60.2	58.1	56.8	56.6	57.1	59.6	61.9	61.4	59.1	59.3	59.9	59.4	56.8	61.0
Hakodate	60.8	61.6	60.9	60.7	58.8	57.4	57.3	57.7	59.8	62.3	61.8	60.0	59.9	60.8	60.1	57.5	61.3
Tokyo	62.2	62.6	61.7	61.5	59.2	57.3	57.6	57.9	59.9	62.6	62.9	61.9	60.6	62.2	60.8	57.6	61.8
Niigata	63.0	63.6	62.8	61.7	59.3	57.1	57.2	57.2	59.7	63.1	63.8	62.4	60.9	63.0	61.3	57.2	62.2
Nagano	63.6	64.0	63.3	61.5	59.2	57.0	56.6	56.7	59.6	63.0	65.0	64.1	61.1	63.9	61.3	56.8	62.5
Numazu	61.3	61.6	61.2	60.9	59.2	57.3	57.6	57.7	59.6	62.0	62.7	61.6	60.2	61.5	60.4	57.5	61.4
Hamamatsu	62.7	62.6	61.9	61.2	59.3	57.4	57.7	57.7	59.5	61.9	63.3	63.0	60.7	62.8	60.8	57.6	61.8
Nagoya	63.1	63.6	62.7	61.2	59.4	57.6	56.9	56.6	59.4	61.9	64.2	64.0	60.9	63.6	61.1	57.0	61.8
Gifu	63.7	63.9	62.9	61.5	59.4	57.3	57.5	57.6	59.6	62.4	64.2	63.9	61.2	63.8	61.3	57.5	62.1
Tsu	63.8	64.2	63.2	61.5	59.5	57.6	57.0	56.5	59.6	62.1	64.7	64.5	61.2	64.2	61.4	57.0	62.1
Wakayama	64.7	64.7	63.3	61.4	59.2	56.9	57.1	57.0	59.1	62.4	64.4	64.7	61.2	64.7	61.3	57.0	62.0
Hiroshima	65.7	65.5	64.0	61.5	59.2	56.7	56.9	56.6	58.8	62.7	65.1	65.4	61.5	65.5	61.6	56.7	62 2
Oita	65.6	65.1	63.7	61.0	59.1	56.3	56.3	56.3	58.5	62.2	65.2	65.7	61.2	65.5	61.3	56.3	62.1
Kumamoto	66.2	65.5	64.0	61.5	59.4	57.4	56.9	57.1	58.2	62.2	66.1	66.6	61.8	66.1	61.6	57.1	62.2
Kagoshima	65.7	65.2	63.4	61.2	59.1	57.1	57.1	56.7	58.2	61.8	65.0	65.9	61.1	65.6	61.2	57.0	61.7
Mean	63.5	63.6	62.6	61.2	59.2	57.1	57.1	57.1	59.3	62.3	64.0	63.5	60.9	63.5	61.0	57.1	61.9
(*B*)																	
Nemuro	57.8	59.5	59.7	60.1	58.9	57.9	57.7	58.2	60.3	61.9	60.5	57.6	59.2	58.3	59.6	57.9	60.9
Akita	62 1	62.7	62.1	61.6	59.4	57.1	57.5	57.5	59.7	63.1	63.4	61.4	60.6	62.1	61.0	57.4	62.1
Yamagata	61.9	62.8	62.7	61.2	59.1	57.2	56.8	56.8	59.9	62.9	63.9	62.6	60.7	62.4	61.0	57.0	62.2
Miyako	60.9	61.0	61.4	61.2	59.4	57.7	58.0	58.2	60.4	63.1	62.7	60.5	60.4	60.4	60.7	58.0	62.1
Ishinomaki	61.0	61.8	62.1	61.0	59.0	56.9	57.1	57.3	59.8	62.6	63.1	61.5	60.2	61.4	60.1	57.1	61.8
Fukushima	61.5	62.4	62.5	61.1	59.3	57.1	57.0	57.1	60.1	62.8	63·6	62.2	60.6	62.0	61.0	57.1	62.2
Utsunomiya	61.1	62.1	61.8	61.1	58.7	57.7	56.9	57.6	60.2	62.5	63.3	62.2	60.4	61.8	60.5	57.4	62.0
Maebashi	55.0	52 9	55.8	51.4	48.1	47.3	48.2	48.7	50.8	53.1	54.1	53.9	51.6	54.0	51.8	48.1	52.7
Hikone	64.5	64.7	63.9	61.9	59.8	57.6	57.6	57.8	59.8	63.0	64.8	64.7	61.7	64.6	61.9	57.7	62.5
Hamada	65.7	65.8	64.1	61.7	59.6	56.9	57.1	56.9	59.2	63.4	65.2	65.3	61.8	65.6	61.8	57.0	62.6
Kochi	64.5	64.3	62.9	61.3	59.1	57.1	57.4	57.2	59.0	62.0	64.5	64.8	61.2	64.5	61.1	57.2	61.8
Mean	61.5	61.8	61.7	60.3	58.2	56.4	56.5	56.7	59.0	61.9	62.6	61.5	59.9	60.8	60.0	56.5	61.2

* Extracted from the "climate of Japan," published by the Imperial Central Meteorological Observatory.

TABLE VIII.

SEASONAL VARIATION OF SEISMIC FREQUENCY AT THE DIFFERENT STATIONS.

(*A*)

Station.	Sp.	Su.	A.	W.
	%	%	%	%
Sapporo	24.1	19.5	31.9	24.4
Hakodate	24.6	21.7	30.2	23.6
Tokyo	25.5	19.1	18.3	23.9
Niigata	38.7	25.8	21.9	14.1
Nagano	35.4	14.2	23.6	26.7
Numazu	30.8	17.4	22.2	29.9
Hamamatsu	25.2	8.9	30.7	35.3
Nagoya	31.6	23.6	18.4	26.5
Gifu	33.0	18.4	23.2	25.4
Tsu	31.8	17.0	19.2	31.8
Wakayama	31.2	24.7	23.1	21.1
Hiroshima	24.3	20.0	28.6	27.1
Oita	23.5	22.0	28.5	26.5
Kumamoto	29.9	22.1	22.4	25.7
Kagoshima	29.3	19.7	27.3	23.7
Mean.	29.1	20.2	23.5	25.8

(*B*)

Station.	Sp.	Su.	A.	W.
	%	%	%	%
Nemuro	25.0	27.0	26.3	21.9
Akita	21.9	34.2	24.0	19.9
Yamagata	29.4	39.6	10.2	20.8
Miyako	25.0	33.8	24.0	17.5
Ishinomaki	21.6	32.2	29.9	16.6
Fukushima	28.9	29.6	21.9	19.7
Utsunomiya	23.6	29.0	22.2	25.3
Maebashi	26.1	26.9	28.3	18.8
Hikone	26.9	32.6	16.7	23.7
Hamada	13.3	19.8	40.1	26.8
Kochi	23.4	25.5	22.0	29.1
Mean.	19.3	24.0	18.0	15.3

TABLE IX.

MEAN MONTHLY BAROMETRIC PRESSURE AT *TOKYO*.*

1876—1885.

Month. / Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX	X.	XI.	XII.	Mean.
1876	65.18	63.03	61.86	61.42	59.93	58.28	60.03	60.10	59.32	6[illegible].83	58.48	63.39	61.15
1877	64.56	61.86	59.50	63.49	61.37	58.53	59.24	57.85	61.02	61.32	64.63	64.81	61.51
1878	63.26	64.82	62.75	64.27	57.95	57.96	57.64	58.98	56.58	64.35	65.35	61.09	61.50
1879	64.61	64.49	61.19	62.84	59.30	58.11	58.94	57.24	59.29	63.93	62.65	59.10	60.97
1880	63.69	65.41	62.68	63.49	59.91	58.68	56.74	57.86	61.81	63.15	61.76	61.12	61.31
1881	58.56	63.50	64.95	61.75	61.19	58.73	58.27	59.28	60.90	62.42	62.43	64.66	61.39
1882	64.32	63.53	62.43	61.22	57.87	56.41	58.71	60.52	61.10	63.86	64.77	63.05	61.48
1883	62.24	65.71	60.74	62.05	59.29	59.30	57.79	59.52	60.95	64.00	64.26	60.67	61.38
1884	63.21	62.94	61.65	62.37	59.64	58.65	59.34	57.58	61.20	63.53	62.03	62.99	61.26
1885	64.10	62.01	61.69	63.84	60.09	57.86	58.40	59.25	60.14	63.03	62.34	62.60	61.28

* Extracted from the "Climate of Japan."

Fig. 9 (1 4) and Fig. 10 (1-3) give graphical illustration of the variations of the monthly seismic frequency and barometric pressure for some typical stations, as follows:—

Fig. 9. (*A* group stations) · (1) Tokyo; (2) Nagoya; (3) Gifu; (4) Kumamoto.

Fig. 10. (*B* group stations): (1) Ishinomaki; (2) Fukushima; (3) Utsunomiya.

For *Tokyo*, *Nagoya*, *Gifu* and *Kumamoto*, the curves of the seismic frequency are much similar to those of the barometric pressure. The minima of the seismic frequency occur in July, August or September, while the minima of barometric pressure occur in June, July or August; the two set of the minima thus occurring practically at the same period of the year. On the other hand, in the cases of *Ishinomaki*, *Fukushima* and *Utsunomiya*, the curves of the seismic and barometric variations are almost opposite to one another.

In the case of Tokyo, the parallelism of the seismic and barometric annual variations may at once be seen by directly plotting in curves the two quantities for successive months or every two successive months. (See Fig. 2.) Table IX gives the mean monthly barometric pressure in Tokyo during the 10 years between 1876 and 1885.

From Fig. 9, it will be seen that the seismic curve for Tokyo indicates principally the annual period, while those for Nagoya, Gifu and Kumamoto, show each, besides the annual period, also more or less definitely the semi-annual period, as indicated by dotted lines.

Fig. 11 (1) shows the variations of the *monthly* seismic frequency and the barometric pressure meaned from the 15 stations belonging to the (*A*) region. The seismic curve indicates maxima in January, April and October, and minima in February, July to September, and December. The mean curve drawn in dotted line will be seen to be, in the main, similar to the curve of the barometric pressure. The latter indicates maxima in November, December, January and February, and minima in June, July and August.

Fig. 11 (2) shows similarly the variations of the *monthly* seismic frequency and the barometric pressure meaned from the 9 stations belonging to the (*B*) region, *Hamada* and *Kochi* being not included. The seismic curve indicates maxima in April, August and November, and minima in January, May and September. The dotted curve drawn through the mean positions of the seismic curve will be seen to be symmetrically opposite to the barometric curve. The latter indicates maxima between October and March, and minima in June, July and August.

The data contained in Tables VII and VIII are illustrated in Fig. 12, the full curves showing the variations of the seasonal seismic frequency and the barometric pressure meaned from all the stations belonging to the (*A*) region; and the dotted curves the similar variations meaned from all the stations belonging to the *B* region. The barometric curve for the (*A*) region indicates the minimum in Summer and the maximum in Winter. The barometric curve for the (*B*) region is very similar to that for the (*A*) region, showing likewise the minimum in Summer and the maximum in Winter. On the other hand, the seismic curves for the two regions are almost perfectly opposite to one another. Thus the curve for the (*A*) region indicates the maximum in Spring and the minimum in Summer; while the curve for the (*B*) region indicates the maximum in Summer and the minimum in Winter. On the whole it will be seen that for the (*A*) region the seismic and barometric variations are similar to one another, while for the (*B*) region these two variations are mutually opposite.

What has thus far been said is an explanation of the suppositions stated in §§ 12 and 13. Our conclusions are as follows.—

(*A*) region: the earthquakes are mostly of inland origin and the annual variation of the seismic frequency follows that of the barometric pressure.

(*B*) region: the earthquakes are mostly of suboceanic origin and the annual variation of the seismic frequency is the reverse of that of the barometric pressure on land.

III. *Diurnal Variation of the Seismic Frequency.*

15. *Diurnal distribution of earthquakes.* Tables X (1–26) give the diurnal (as well as the annual) distribution of earthquakes for the 26 different stations.

TABLE X

NEMURO. DIURNAL DISTRIBUTION OF 991 EARTHQUAKES.*

March 23rd, 1894—Dec. 31st, 1899.

All instrumentally observed.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0– 1 a.m.	0	1	19	6	0	2	1	4	4	2	0	0	39
1– 2	1	3	7	7	4	3	4	2	1	4	3	1	40
2– 3	0	0	11	10	3	3	1	0	4	3	2	3	40
3– 4	1	0	19	6	1	4	3	3	4	4	3	2	50
4– 5	1	1	22	3	7	4	2	2	1	2	0	5	50
5– 6	2	2	23	3	5	3	2	2	1	2	2	1	48
6– 7	2	2	19	7	6	1	1	1	1	0	3	1	44
7– 8	1	1	21	6	4	4	3	2	2	3	2	1	50
8– 9	1	0	13	10	5	3	4	1	2	2	3	0	44
9–10	0	0	9	5	2	3	3	2	2	5	1	5	37
10–11	2	1	7	10	4	5	2	3	3	2	2	2	43
11–12	1	4	12	10	4	4	4	3	0	5	4	2	53
0– 1 p.m.	1	2	18	2	5	5	2	1	1	2	2	0	41
1– 2	3	0	8	4	2	1	2	2	2	0	0	2	26
2– 3	1	0	7	5	0	2	1	2	2	4	1	0	25
3– 4	1	3	14	5	2	1	6	1	1	6	3	2	45
4– 5	0	0	13	3	3	2	4	7	5	2	5	0	44
5– 6	1	2	10	6	5	6	5	1	2	0	2	2	42
6– 7	2	0	12	4	3	5	1	2	3	4	1	1	38
7– 8	0	1	16	9	3	3	2	1	2	2	1	3	43
8– 9	0	1	11	14	5	0	2	1	2	3	1	1	41
9–10	3	1	18	3	2	1	2	2	4	3	1	1	41
10–11	0	0	4	5	2	6	3	3	3	3	1	0	30
11–12	1	1	10	4	2	3	5	4	1	2	1	3	37
Sum.	25	26	323	147	79	74	65	52	53	65	44	38	991

* The great Hokkaido Earthquake happened on March 22nd 1894, at 7 h 56 m p.m. (*Nemuro*). The present table includes all the earthquakes which took place since the following day, March 23rd 1894.

TABLE X (2).

SAPPORO. DIURNAL DISTRIBUTION OF 153 EARTHQUAKES.

Sep. 1876—Dec. 1899.

Instrumentally observed since Jan. 1883.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0– 1 a.m.	0	1	0	2	0	0	1	1	1	1	0	0	7
1 - 2	0	1	0	1	0	0	0	0	1	0	1	2	6
2 - 3	0	3	1	0	0	2	0	1	0	0	0	0	7
3– 4	0	0	0	2	0	0	1	1	3	1	0	1	9
4– 5	1	3	0	0	0	1	0	1	0	0	0	1	7
5 - 6	0	1	0	0	0	1	1	0	0	1	2	0	6
6 - 7	0	1	0	0	0	0	0	0	1	1	2	0	5
7 - 8	0	0	1	0	0	0	1	1	0	0	2	1	6
8 9	1	2	0	1	0	0	0	0	1	0	0	0	5
9–10	0	1	1	0	0	1	0	0	1	1	2	1	8
10-11	1	0	0	0	1	0	0	0	0	0	0	0	2
11-12	0	2	0	0	0	0	0	0	0	1	1	2	6
0– 1 p.m.	0	0	0	1	2	0	1	0	0	1	2	1	8
1– 2	0	0	1	0	0	0	0	0	0	0	0	0	1
2– 3	0	2	0	0	0	0	0	0	0	0	0	1	3
3– 4	0	0	0	3	0	1	1	0	0	1	2	1	9
4– 5	1	0	1	1	1	0	0	0	0	1	0	0	5
5– 6	1	0	1	2	0	0	0	0	0	3	0	0	7
6– 7	0	0	1	0	1	0	0	2	0	0	0	0	4
7– 8	1	2	2	0	0	1	0	0	1	2	2	0	11
8– 9	0	0	0	1	1	2	0	0	0	1	0	0	5
9–10	0	0	1	1	0	0	0	1	1	3	0	1	8
10–11	0	0	1	2	0	0	1	1	2	2	1	0	10
11–12	0	1	2	0	0	2	0	2	1	0	0	0	8
Sum.	6	20	13	17	6	11	7	11	13	20	17	12	153

TABLE X (3).

HAKODATE. DIURNAL DISTRIBUTION OF 300 EARTHQUAKES.

Jan. 1873—Dec. 1899.

Instrumentally observed since Jan. 1st, 1895.

Hour. \ month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h 0- 1a.m.	1	2	0	2	2	0	1	0	2	2	2	0	14
1- 2	0	1	0	1	0	1	1	2	1	1	3	4	15
2- 3	1	1	1	2	1	2	1	1	0	3	1	1	15
3- 4	3	1	1	2	1	0	1	1	1	1	2	0	14
4- 5	1	1	1	2	0	1	0	1	0	1	0	0	8
5- 6	0	3	1	1	1	0	1	1	0	1	1	3	13
6- 7	1	0	0	0	2	2	1	0	0	0	2	0	8
7- 8	1	1	1	1	0	1	3	1	0	0	2	0	11
8- 9	0	2	0	2	1	1	0	0	0	1	1	0	8
9-10	0	0	3	2	0	1	0	2	0	0	2	2	12
10-11	1	2	0	1	0	0	0	0	1	4	2	0	11
11-12	0	0	0	0	0	1	1	0	1	2	1	1	7
0- 1p.m.	2	0	1	0	3	3	2	0	3	1	2	1	18
1- 2	0	1	0	1	1	1	0	1	1	0	2	0	8
2- 3	0	2	2	0	3	0	0	1	0	2	1	1	12
3- 4	1	0	0	1	1	1	1	0	0	4	1	0	10
4- 5	1	4	2	1	1	1	1	1	2	0	3	0	17
5- 6	1	1	3	0	0	0	3	1	0	2	0	0	11
6- 7	0	0	1	2	1	2	1	1	2	2	2	2	16
7- 8	1	3	2	2	0	3	0	2	2	4	1	2	22
8- 9	1	0	1	1	0	1	2	0	0	1	1	2	10
9-10	0	1	1	2	3	1	1	0	0	3	1	0	13
10-11	2	0	2	1	1	0	0	2	1	2	1	2	14
11-12	2	3	2	0	0	2	0	1	1	1	1	1	14
Sum.	20	29	25	27	22	25	21	19	18	38	34	22	300

TABLE X (4).

AKITA. DIURNAL DISTRIBUTION OF 373 EARTHQUAKES.

Jan. 1883—Dec. 1899.

Instrumentally observed since July, 1894.

Month. / Hour.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0- 1 a.m.	0	1	0	0	1	0	0	1	8	1	0	1	13
1 2	0	1	0	1	0	1	0	0	10	0	0	0	13
2 3	1	1	0	2	2	0	0	0	7	0	0	1	14
3 4	0	0	0	2	0	1	1	0	10	0	1	0	15
4 5	0	1	0	0	0	0	1	0	11	0	0	0	13
5 6	2	1	1	1	1	0	1	2	4	3	0	0	16
6 7	0	1	1	0	1	0	1	2	5	1	0	0	12
7 8	2	1	0	0	0	2	0	0	1	0	1	1	8
8 9	1	1	0	1	0	1	0	4	4	2	2	0	16
9 10	1	1	0	2	0	1	1	8	4	0	0	1	19
10-11	0	1	0	0	1	0	1	2	1	0	2	1	9
11 12	0	0	0	0	3	0	0	2	5	3	0	0	13
0 1 p.m.	1	0	0	0	2	2	0	0	3	0	1	1	10
1 2	0	0	1	1	1	3	0	1	3	0	1	0	11
2 3	0	0	0	3	0	2	1	2	5	2	0	0	15
3 4	1	0	0	0	2	2	1	3	3	0	0	0	12
4 5	0	1	1	0	0	1	3	2	5	0	2	1	16
5- 6	0	1	2	0	0	2	1	14	3	4	1	1	*16
6 - 7	0	0	2	1	0	0	4	21	2	2	1	1	*14
7 8	0	1	2	2	1	1	2	8	2	0	1	0	20
8- 9	0	2	0	0	1	0	2	4	9	1	0	2	21
9-10	0	1	0	0	2	0	3	4	2	2	1	1	16
10-11	3	0	1	0	0	2	0	6	2	3	0	1	18
11-12	0	0	0	0	0	1	1	4	1	1	2	0	10
Sum.	12	16	11	16	18	22	24	90	110	25	16	13	373

* In deducing the *sums* for 5-6 p.m. and 6-7 p.m., the August numbers have been excluded, on account of the after shocks of the great Rikū-U earthquake of Aug. 31st, 1893.

TABLE X (5).

MIYAKO. DIURNAL DISTRIBUTION OF 704 EARTHQUAKES.

March. 1883—Dec. 1899.

Instrumentally observed since June 1896.

Month. / Hour.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0- 1 a.m.	1	4	2	5	1	4	1	7	2	1	2	1	31
1- 2	0	4	0	4	2	1	4	4	4	2	3	1	29
2- 3	5	3	0	2	4	3	3	0	2	1	3	4	30
3- 4	1	2	3	2	1	3	1	2	2	2	3	1	23
4- 5	2	3	2	2	0	3	3	4	1	2	0	2	24
5- 6	1	5	0	3	3	1	0	3	1	2	3	0	22
6- 7	0	3	1	2	0	6	5	2	1	0	2	1	23
7- 8	1	2	1	2	1	4	4	4	3	1	2	1	26
8- 9	1	3	3	2	2	7	2	5	2	1	5	0	33
9-10	0	1	1	7	2	4	3	10	2	0	3	1	34
10-11	2	1	0	1	3	5	8	8	1	1	3	2	35
11-12	0	0	1	1	2	5	0	7	5	4	2	3	30
0- 1 p.m.	1	3	0	3	2	2	1	3	3	2	2	1	23
1- 2	2	3	2	2	1	10	2	3	3	3	2	4	37
2- 3	2	3	0	2	0	3	0	1	1	3	2	1	18
3- 4	1	2	4	1	2	5	3	4	2	2	0	1	27
4- 5	0	6	2	2	0	4	3	7	3	2	3	2	34
5- 6	1	4	5	3	0	4	5	12	2	4	0	2	42
6- 7	1	1	1	1	2	3	7	9	1	4	3	2	35
7- 8	4	2	6	4	2	3	3	4	2	1	3	1	35
8- 9	1	2	3	3	3	8	3	2	6	5	0	1	37
9-10	0	2	1	1	3	6	2	2	2	5	1	1	26
10-11	5	2	4	0	1	6	2	0	0	4	1	3	28
11-12	0	2	2	0	1	6	2	3	4	0	1	1	22
Sum.	32	63	44	55	38	106	67	106	55	52	49	37	704

TABLE X.(6).

YAMAGATA. DIURNAL DISTRIBUTION OF 197 EARTHQUAKES.

Dec. 1889 - Dec. 1899.

Instrumentally observed since Sept. 1894.

Month. / Hour. h h	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0 1 a.m.	2	0	0	0	0	0	0	2	1	0	0	1	**6**
1 2	0	3	0	5	0	2	2	0	0	0	0	1	**13**
2 3	0	0	0	1	1	1	0	0	1	0	0	1	**5**
3 4	0	1	1	0	2	0	2	0	0	0	0	0	**6**
4 5	0	0	0	0	0	1	0	1	1	0	0	0	**3**
5 6	1	2	0	0	2	0	1	0	0	0	0	1	**7**
6 7	0	0	1	1	3	2	1	1	0	0	0	0	**9**
7 - 8	0	2	0	0	3	0	0	0	0	0	0	1	**6**
8 9	1	1	0	1	2	4	0	2	0	0	0	0	**11**
9 10	0	0	0	3	1	2	0	5	1	0	0	1	**13**
10 11	0	0	0	1	2	0	2	3	1	0	0	1	**10**
11 12	0	0	0	1	0	0	0	2	0	0	1	2	**6**
0 1 p.m.	1	0	0	0	1	1	2	1	0	1	0	0	**7**
1 - 2	1	0	0	0	3	4	1	0	1	0	0	1	**11**
2 - 3	0	0	0	1	2	1	0	0	0	0	0	0	**4**
3 4	1	0	1	0	1	1	2	1	0	0	0	1	**8**
4 - 5	1	1	0	2	1	1	0	2	1	0	0	1	**10**
5 - 6	1	0	2	1	1	0	1	2	3	0	0	1	**12**
6 7	1	1	0	1	1	1	5	6	1	2	0	0	**19**
7 - 8	1	1	3	0	1	1	0	2	0	0	0	0	**9**
8 - 9	0	0	0	1	0	1	0	1	2	0	0	1	**6**
9 10	0	1	0	0	1	1	0	0	0	1	0	0	**4**
10 11	2	0	0	0	1	2	1	1	0	0	0	0	**7**
11 12	0	1	1	0	0	0	0	0	0	2	0	1	**5**
Sum.	13	14	9	19	29	26	20	32	13	6	1	15	**197**

TABLE X

ISHINOMAKI. DIURNAL DISTRIBUTION OF 1034 EARTHQUAKES.

Jan. 1886—Dec. 1899.

Instrumentally observed since 1891.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX	X.	XI.	XII.	Sum.
h h													
0– 1 a.m.	1	2	0	0	1	2	2	4	6	3	2	0	23
1– 2	1	5	0	3	3	3	7	3	4	5	3	4	41
2 3	3	1	0	4	3	7	4	2	1	1	5	3	34
3 4	0	3	4	3	3	2	1	4	0	3	5	2	30
4 5	3	2	2	5	7	2	3	7	2	3	3	1	40
5– 6	0	5	4	6	4	1	4	3	4	1	0	5	37
6– 7	2	2	5	1	2	3	8	7	2	4	4	0	40
7– 8	0	3	3	2	2	4	2	2	5	1	2	2	28
8– 9	2	3	0	5	3	4	2	4	5	4	7	2	41
9–10	1	0	1	5	5	6	2	11	2	4	5	1	43
10–11	3	2	0	2	4	4	4	10	8	6	4	4	51
11–12	0	1	1	5	2	0	4	9	7	2	3	5	39
0– 1 p.m.	2	0	1	4	4	4	2	5	3	2	4	2	33
1– 2	1	1	3	5	5	8	7	6	7	5	9	5	62
2– 3	4	7	5	3	8	5	13	12	9	7	10	7	90
3– 4	2	2	2	2	4	2	5	7	8	3	4	5	46
4– 5	2	3	2	3	3	4	3	8	2	6	9	2	47
5– 6	3	4	4	5	4	0	10	5	4	7	4	3	53
6– 7	0	2	2	4	5	5	10	12	5	6	5	1	57
7– 8	2	1	3	6	3	3	5	4	8	0	1	0	36
8– 9	1	1	3	2	2	3	6	4	8	4	9	5	48
9–10	2	4	3	5	6	2	5	2	3	2	2	1	37
10–11	5	2	3	3	2	2	7	4	2	8	9	7	54
11–12	2	3	3	1	0	1	3	1	3	0	4	3	24
Sum.	42	59	54	84	85	77	119	136	108	87	113	70	1034

TABLE X

FUKUSHIMA. DIURNAL DISTRIBUTION OF 857 EARTHQUAKES.

May 1889—Dec. 1899.

Instrumentally observed since March 27th, 1895.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0 1 a.m.	3	1	1	4	1	3	2	3	2	2	7	1	**30**
1 2	1	7	1	5	3	2	2	1	5	3	4	1	**35**
2 3	2	3	4	4	2	0	0	2	2	0	2	4	**25**
3 4	0	5	5	8	2	2	4	2	4	2	3	2	**39**
4 5	2	2	4	1	2	5	0	4	1	1	1	0	**23**
5 6	3	6	4	3	4	3	3	2	3	2	1	2	**36**
6 7	1	2	3	4	7	5	8	6	1	0	4	4	**45**
7 8	2	2	0	5	0	3	2	2	6	0	3	1	**26**
8 9	6	4	1	3	5	3	3	6	0	3	3	2	**39**
9 10	5	2	2	10	4	4	4	7	3	1	4	4	**50**
10-11	3	1	0	2	4	1	2	5	3	4	2	3	**30**
11 12	3	0	2	1	1	1	4	6	5	3	2	5	**33**
0 1 p.m.	1	2	0	2	1	6	3	6	1	1	2	1	**26**
1 2	1	1	3	6	2	7	4	4	2	5	4	2	**41**
2 3	3	2	2	7	8	5	1	1	3	3	1	1	**37**
3 4	1	2	3	3	1	3	3	2	1	2	3	2	**26**
4 - 5	2	3	0	2	3	5	3	6	2	3	5	2	**36**
5 - 6	0	1	4	10	3	7	4	4	1	4	1	2	**41**
6 7	4	3	3	3	4	4	8	7	0	6	5	2	**49**
7 8	0	4	9	7	2	7	2	5	4	3	3	1	**47**
8 - 9	2	1	4	6	1	5	5	2	6	3	3	3	**41**
9 10	0	4	2	4	2	5	3	3	3	1	3	1	**31**
10 -11	7	2	5	3	2	4	4	2	3	4	6	2	**44**
11-12	0	0	5	2	2	1	3	5	3	2	0	4	**27**
Sum.	52	60	67	105	66	91	77	93	64	58	72	52	**857**

TABLE X (9).

UTSUNOMIYA. DIURNAL DISTRIBUTION OF 492 EARTHQUAKES.

Jan. 1894—Dec. 1899.

Observed instrumentally since July 1893.

Hour \ Month	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0 1a.m.	3	0	1	1	0	3	2	1	0	1	0	3	15
1 2	3	1	1	2	2	1	0	2	3	0	1	2	18
2 3	0	1	1	1	3	0	3	1	0	0	3	1	14
3- 4	1	2	2	6	3	2	0	0	0	0	3	1	20
4- 5	2	1	1	1	1	2	1	2	1	1	0	0	13
5- 6	3	3	1	1	1	2	3	2	1	2	0	1	20
6- 7	1	2	3	3	2	1	5	3	2	4	2	2	30
7- 8	0	2	1	0	2	4	0	2	1	0	3	0	15
8- 9	6	5	0	4	0	0	1	4	1	1	2	2	26
9-10	2	2	0	3	2	2	1	6	2	1	3	1	25
10-11	3	2	0	2	2	3	2	3	5	3	1	2	28
11-12	2	0	2	0	2	1	1	4	2	2	2	4	22
0- 1p.m.	3	1	1	0	3	1	4	4	0	1	0	1	19
1- 2	2	0	3	3	0	5	1	1	0	5	3	1	24
2- 3	3	2	1	1	4	3	2	1	2	3	1	0	23
3- 4	1	1	0	3	2	2	1	0	1	5	2	2	20
4- 5	1	1	1	1	0	1	3	3	1	1	0	4	17
5- 6	1	1	1	1	2	3	3	2	0	2	0	0	16
6- 7	1	2	3	0	2	2	3	4	0	5	1	1	24
7- 8	1	3	3	4	2	4	2	1	0	4	0	1	25
8- 9	0	2	3	2	2	1	3	1	2	2	1	3	22
9-10	3	4	0	2	1	1	2	2	3	3	4	1	26
10-11	4	1	2	2	0	2	2	0	1	1	2	1	18
11-12	3	1	2	1	1	0	1	1	0	0	0	2	12
Sum.	49	40	33	44	39	46	46	50	28	47	34	36	492

TABLE X (*10*).

TOKYO. DIURNAL DISTRIBUTION OF 2208 EARTHQUAKES.

Jan. 1876—Dec. 1876.

All Instrumentally observed.

Month. / Hour. h h	I.	II.	III.	IV.	V.	VI.	VII	VIII.	IX.	X.	XI.	XII.	Sum.
0- 1 a.m.	11	9	4	12	6	6	9	5	5	8	9	8	**92**
1 2	5	8	5	7	10	8	4	5	8	4	8	9	**81**
2 3	7	11	8	9	9	8	9	5	5	5	11	3	**90**
3 4	5	5	10	13	7	7	5	5	3	6	9	10	**85**
4 5	6	4	11	7	8	4	5	8	3	4	4	7	**71**
5 6	9	9	9	12	5	6	4	6	10	3	3	11	**87**
6 7	6	11	11	5	14	4	8	6	3	11	7	9	**95**
7- 8	8	11	6	8	10	9	5	7	4	13	1	10	**92**
8 9	10	9	5	8	16	11	3	10	9	3	7	5	**96**
9 10	8	6	8	7	14	13	9	11	5	10	13	9	**113**
10 11	12	5	5	8	10	9	6	8	7	7	8	8	**93**
11-12	8	7	6	7	6	9	4	9	6	8	4	10	**84**
0- 1 p.m.	3	7	3	6	11	13	7	7	4	2	7	9	**79**
1- 2	6	7	9	8	4	13	3	6	6	12	11	6	**91**
2- 3	7	12	11	8	8	9	9	5	4	7	0	5	**85**
3 4	9	13	8	13	9	8	9	2	8	9	12	4	**104**
4- 5	7	3	13	10	5	11	10	9	5	5	10	9	**97**
5- 6	7	8	8	7	10	7	7	7	3	7	5	5	**81**
6- 7	9	5	10	2	11	10	8	10	3	10	5	6	**89**
7- 8	10	5	16	9	6	7	6	6	4	13	6	5	**93**
8- 9	5	5	12	10	7	2	10	5	9	16	9	14	**104**
9-10	8	13	6	9	8	13	11	6	5	5	9	7	**100**
10-11	16	8	15	13	3	7	10	5	4	10	6	10	**107**
11-12	11	11	16	7	13	8	6	5	6	3	4	9	**99**
Sum.	193	192	215	205	210	202	167	158	129	181	168	188	**2208**

TABLE X (*11*).

MAEBASHI. DIURNAL DISTRIBUTION OF 126 EARTHQUAKES.

Dec. 1896—Dec. 1899.

All Instrumentally observed.

Month. / Hour.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0 1 a.m.	1	0	0	1	0	0	0	1	0	0	1	1	5
1– 2	0	2	0	0	0	1	0	1	1	0	0	1	6
2– 3	0	0	0	0	1	0	1	0	0	0	1	0	3
3– 4	0	0	1	0	1	1	0	0	0	0	0	0	3
4– 5	0	0	0	1	0	0	0	1	1	0	0	1	4
5– 6	1	1	1	0	0	0	1	1	0	0	0	1	6
6– 7	0	0	1	1	1	0	3	0	0	0	2	0	8
7– 8	0	0	0	0	0	0	0	0	0	0	1	0	1
8– 9	2	2	1	2	0	0	0	0	1	0	0	0	8
9–10	0	0	1	0	0	1	0	2	1	0	1	2	8
10–11	0	0	1	0	1	1	0	1	0	0	0	2	6
11–12	0	0	0	0	0	0	0	1	0	0	2	0	3
0– 1 p.m.	0	0	0	0	1	0	1	0	1	0	0	0	3
1– 2	0	0	2	1	0	0	0	0	0	0	0	0	3
2– 3	1	0	1	0	1	0	1	1	0	3	0	1	9
3– 4	0	0	1	0	0	1	0	0	1	2	0	1	6
4– 5	0	1	0	0	0	0	1	1	1	0	2	1	7
5– 6	0	0	1	0	0	0	0	1	0	2	0	0	4
6– 7	0	0	1	0	0	0	2	1	2	1	1	0	8
7– 8	0	0	2	1	0	0	1	0	0	0	0	0	4
8– 9	0	0	2	1	0	0	0	0	1	1	0	0	5
9–10	0	0	0	0	1	0	0	1	0	1	1	0	4
10–11	0	0	0	0	0	1	2	0	0	1	1	0	5
11–12	0	2	1	0	0	0	0	1	0	1	0	2	7
Sum.	5	8	17	8	7	6	13	14	10	12	13	13	126

TABLE X (12).

NIIGATA. DIURNAL DISTRIBUTION OF 216 EARTHQUAKES.

April 1886—Dec. 1899.

Instrumentally observed since Jan. 1894.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0– 1 a.m.	1	0	0	2	1	0	1	0	0	1	0	0	**6**
1– 2	0	0	0	1	0	0	0	0	0	0	1	1	**3**
2– 3	2	0	0	2	2	3	0	0	1	0	0	0	**10**
3– 4	0	1	0	1	2	1	0	0	1	0	0	1	**7**
4– 5	0	1	0	1	2	2	0	0	2	0	1	0	**9**
5– 6	2	1	0	1	0	1	1	0	0	0	1	0	**7**
6– 7	0	1	1	0	0	1	1	0	0	2	2	0	**8**
7– 8	0	1	1	1	2	1	0	0	0	1	0	0	**7**
8– 9	2	1	0	3	1	0	0	2	0	1	0	0	**10**
9–10	0	1	0	0	3	1	1	2	2	0	0	1	**11**
10–11	0	0	2	1	4	0	0	2	0	0	0	1	**10**
11–12	1	0	0	1	1	0	2	1	2	2	1	0	**11**
0– 1 p.m.	0	0	0	0	0	0	1	0	1	0	0	0	**2**
1– 2	0	1	0	0	0	2	1	0	1	2	1	0	**8**
2– 3	0	0	0	0	2	2	0	0	0	0	1	0	**5**
3– 4	1	0	0	1	1	1	1	1	1	3	0	0	**10**
4– 5	0	1	0	1	1	0	0	3	2	0	2	1	**11**
5– 6	0	0	3	1	1	2	1	1	0	2	0	0	**11**
6– 7	0	0	0	1	1	1	2	0	0	1	1	0	**7**
7– 8	0	1	1	5	0	2	0	0	0	0	1	1	**11**
8– 9	0	0	1	3	2	6	2	0	1	2	0	0	**17**
9–10	0	0	0	3	3	0	0	0	0	1	0	0	**7**
10–11	3	0	1	5	0	2	1	0	0	1	0	0	**13**
11–12	0	1	1	9	0	1	0	0	1	1	1	0	**15**
Sum.	12	11	11	43	29	29	15	12	15	20	13	6	**216**

TABLE X (13).

NAGOYA. DIURNAL DISTRIBUTION OF 307 EARTHQUAKES.

March 1889—Dec. 1899.

Instrumentally observed since April 1889.

Hour. (h h) \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0- 1 a.m.	0	1	0	1	0	0	1	0	2	0	2	2	9
1- 2	1	1	3	2	2	0	0	1	1	1	0	2	14
2- 3	1	4	0	0	1	0	2	0	0	1	0	0	9
3- 4	1	0	2	3	3	1	0	0	0	0	0	0	10
4- 5	1	1	1	2	0	0	0	0	0	0	1	0	6
5- 6	1	2	2	1	2	2	0	1	0	2	0	1	14
6- 7	0	2	2	1	3	0	1	0	0	1	1	2	13
7- 8	0	1	0	2	0	0	1	0	0	2	0	0	6
8- 9	1	1	1	2	1	0	1	0	1	1	0	1	10
9-10	3	1	1	1	3	1	1	1	2	1	2	1	18
10-11	1	1	2	0	2	0	1	1	0	2	3	2	15
11-12	3	0	0	0	0	3	0	1	0	0	2	2	11
0- 1 p.m.	0	0	0	1	3	2	0	0	0	0	0	2	8
1- 2	1	1	2	0	2	1	0	0	1	1	0	0	9
2- 3	1	4	3	2	2	2	0	0	0	3	1	1	19
3- 4	4	1	2	2	5	0	1	0	0	1	2	0	18
4- 5	0	4	1	1	6	2	1	1	1	3	2	1	23
5- 6	1	1	1	2	2	1	3	0	0	2	1	1	15
6- 7	2	0	0	0	2	1	2	0	1	4	1	0	13
7- 8	0	1	3	2	0	0	0	1	0	1	1	1	10
8- 9	1	0	1	1	0	0	1	1	1	6	2	1	15
9-10	1	1	0	2	6	0	0	0	1	2	2	1	16
10-11	2	3	2	4	2	0	2	0	0	1	1	0	17
11-12	0	0	2	0	1	0	1	2	0	1	2	0	9
Sum.	26	31	31	32	48	16	19	10	11	36	26	21	307

TABLE X (14).

NUMAZU. DIURNAL DISTRIBUTION OF 126 EARTHQUAKES.

Dec. 1884—Dec. 1899.

Observed non-instrumentally.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h 0 - 1 a.m.	1	1	1	0	1	1	0	0	1	1	1	0	8
1 2	1	0	0	0	1	1	0	0	2	1	0	1	7
2 3	0	2	1	0	0	2	0	0	1	2	0	0	8
3 4	0	1	1	3	0	0	0	0	0	1	0	0	6
4 5	1	0	0	0	0	1	0	0	0	0	0	0	2
5 6	0	1	0	0	0	0	0	0	2	1	0	1	5
6 7	0	2	3	1	1	0	1	0	0	3	0	0	11
7 8	0	0	1	0	0	2	0	0	0	1	0	0	4
8 9	1	1	1	1	0	0	0	0	1	1	0	0	6
9 10	0	0	2	0	0	0	0	1	0	0	1	0	4
10 11	1	1	1	2	2	0	0	0	0	1	1	0	9
11 12	0	0	0	0	0	1	0	0	2	0	1	0	4
0 1 p.m.	0	0	1	0	0	0	1	1	1	0	0	0	4
1- 2	2	1	1	1	0	0	0	1	0	1	0	2	9
2- 3	1	2	1	3	1	2	0	0	0	0	0	0	10
3- 4	2	0	0	0	1	0	1	0	1	0	0	0	5
4 5	1	0	0	0	0	0	0	2	0	0	0	0	3
5 - 6	1	0	0	0	0	0	1	1	0	2	0	1	6
6 7	3	0	0	0	0	0	1	1	3	0	1	1	10
7- 8	2	1	2	1	1	0	0	0	0	0	1	1	9
8- 9	0	0	0	1	0	0	0	0	0	1	1	1	4
9-10	0	1	1	1	1	1	0	0	1	1	0	0	7
10-11	5	0	1	2	1	1	2	0	0	1	2	1	16
11 12	0	1	3	0	0	0	1	0	0	0	0	0	5
Sum.	22	15	21	16	10	12	8	7	15	18	9	9	162

TABLE X (15).

HAMAMATSU. DIURNAL DISTRIBUTION OF 99 EARTHQUAKES.

Jan. 1885—Dec. 1893.

Observed non-instrumentally.

Hour. h h \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0 - 1 a.m.	0	0	0	2	0	0	0	0	0	1	0	0	3
1 2	0	1	0	1	0	1	0	0	0	1	1	0	5
2 - 3	0	1	0	0	0	0	0	0	0	2	1	1	5
3 - 4	0	1	0	0	1	0	0	1	0	0	0	0	3
4 5	0	0	0	0	0	0	0	0	0	0	0	0	0
5 6	0	1	0	0	0	0	0	0	2	0	0	1	4
6 - 7	1	0	0	1	0	0	0	0	0	2	0	0	4
7 8	0	0	0	0	0	2	0	0	0	3	0	0	5
8 - 9	1	0	0	0	0	0	0	0	0	2	1	0	4
9 10	0	0	1	0	0	0	0	0	0	0	1	0	2
10 11	0	0	1	0	1	0	0	0	0	1	1	1	5
11 12	0	1	0	0	1	0	0	0	1	1	1	0	5
0 - 1 p.m.	0	0	0	1	0	0	0	0	0	0	0	0	1
1 - 2	0	0	0	0	0	1	0	0	0	1	1	1	4
2 - 3	1	2	0	1	1	0	0	0	0	1	1	0	7
3 - 4	2	0	1	0	0	0	0	0	0	1	0	0	4
4 - 5	1	1	0	1	1	0	0	0	0	0	1	0	5
5 - 6	0	0	0	1	1	0	1	0	0	1	1	1	6
6 - 7	3	0	0	0	0	0	0	0	0	0	0	0	3
7 - 8	0	0	0	0	0	0	0	1	0	4	0	0	5
8 - 9	0	0	0	0	0	0	0	0	0	1	2	1	4
9 - 10	1	0	1	1	0	0	0	0	0	2	1	1	7
10 - 11	2	1	0	1	0	0	0	0	0	0	3	0	7
11 - 12	0	0	0	0	0	0	0	0	0	1	0	0	1
Sum.	12	9	4	10	6	4	1	2	3	25	16	7	99

TABLE X (16).

NAGOYA. DIURNAL DISTRIBUTION OF 1854 EARTHQUAKES.

Oct. 29th, 1891—Dec. 1899.

All instrumentally observed.

Month. / Hour. h h	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0– 1 a.m.	7	1	4	5	5	4	0	1	5	30	30	7	99
1– 2	13	3	6	5	5	2	2	5	2	24	42	8	117
2– 3	14	4	7	2	5	0	3	6	3	19	24	9	96
3– 4	9	4	6	3	2	1	2	5	3	20	34	12	101
4– 5	14	4	8	4	3	2	3	4	3	22	22	14	103
5– 6	10	4	4	2	5	2	2	3	5	15	21	9	82
6– 7	5	6	2	1	2	1	1	3	2	14	14	10	61
7– 8	7	5	4	2	2	5	0	2	2	16	10	5	60
8– 9	8	8	7	4	2	6	0	8	0	22	12	5	82
9–10	5	2	7	2	1	5	2	5	2	11	20	5	67
10–11	6	3	3	2	2	4	2	7	2	10	13	3	57
11–12	6	4	6	6	4	5	1	3	5	14	22	6	82
0– 1 p.m.	4	7	4	0	0	2	3	4	3	16	9	3	55
1– 2	19	4	5	4	3	2	2	4	2	12	12	10	79
2– 3	9	3	3	1	3	2	0	4	2	17	11	1	56
3– 4	7	2	4	6	3	4	3	2	4	18	12	7	72
4– 5	6	4	3	5	4	2	3	1	5	12	14	6	65
5– 6	5	4	5	6	2	4	5	8	4	14	17	4	78
6– 7	6	3	0	0	1	1	4	6	2	15	10	7	55
7– 8	9	3	8	3	1	1	2	2	2	17	18	9	75
8– 9	8	1	0	2	3	3	1	1	1	11	25	11	67
9–10	8	6	7	5	3	2	0	2	0	13	24	9	79
10–11	9	6	5	6	4	0	4	1	5	18	23	4	85
11–12	8	6	7	4	3	4	2	3	2	19	18	5	81
Sum.	202	97	115	80	68	64	47	90	66	399	457	169	1854

TABLE X (17).

GIFU. DIURNAL DISTRIBUTION OF 4113 EARTHQUAKES.

Oct. 29th. 1981—Dec. 1899.

All instrumentally observed.

Month. / Hour.	I.	II.	III.	IV.	V.	VI.	VII	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0 - 1 a.m.	13	6	8	6	3	1	2	0	7	24	63	14	147
1 - 2	15	6	11	7	2	3	1	6	5	32	70	19	177
2 - 3	12	8	13	10	7	3	3	8	8	40	67	22	201
3 - 4	9	5	11	8	4	3	4	4	6	42	53	21	170
4 - 5	7	9	5	8	8	4	4	3	6	60	62	24	200
5 - 6	14	8	5	11	11	3	2	6	8	40	64	24	196
6 - 7	11	9	4	13	9	5	10	3	10	21	57	22	174
7 - 8	17	5	6	10	7	10	4	5	9	28	42	15	158
8 - 9	9	9	7	7	7	6	1	8	3	36	37	24	154
9 10	10	12	6	12	6	8	5	5	3	21	37	22	147
10 11	13	3	4	11	4	2	7	3	4	22	45	21	139
11-12	10	5	5	6	8	6	4	2	8	38	55	18	165
0 - 1 p.m.	12	9	10	5	6	4	2	3	10	38	39	32	170
1 - 2	15	11	7	10	3	2	6	7	8	33	41	25	168
2 - 3	10	8	8	12	4	3	5	5	9	17	50	19	150
3 - 4	7	4	10	5	6	6	5	8	9	25	36	26	147
4 - 5	10	7	5	8	6	4	5	9	3	25	37	19	138
5 - 6	16	9	5	5	5	4	7	4	10	21	50	21	157
6 - 7	20	8	10	10	10	2	5	6	4	32	42	32	181
7 - 8	24	14	11	4	4	6	3	7	7	46	63	21	210
8 - 9	17	11	14	17	3	4	5	3	12	36	53	19	194
9-10	8	8	12	13	4	5	3	4	7	24	60	35	183
10-11	28	13	9	17	6	7	8	6	13	26	62	24	219
11-12	15	15	9	8	9	7	7	5	8	16	55	14	168
Sum.	322	202	195	223	142	108	108	120	177	743	1240	533	4113

TABLE X. (18).

TSU. DIURNAL DISTRIBUTION OF 416 EARTHQUAKES.

July 1889—Dec. 1899.

Instrumentally observed since Feb. 1899.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0– 1 a.m.	0	1	1	2	0	0	0	2	0	4	9	0	19
1– 2	0	0	0	0	0	0	0	0	0	3	4	3	10
2– 3	3	3	3	0	0	0	0	0	1	4	5	2	21
3– 4	1	0	1	1	0	0	1	2	0	5	4	1	16
4– 5	0	1	0	1	0	0	0	0	0	4	6	0	12
5– 6	2	1	2	0	0	0	0	0	1	3	0	2	11
6– 7	1	2	0	1	0	0	0	1	0	16	5	4	*15
7– 8	0	0	0	0	0	1	0	0	0	32	5	4	*9
8– 9	1	0	1	1	0	1	0	0	0	9	1	0	14
9–10	1	0	1	1	0	0	0	0	0	5	4	1	13
10–11	0	0	4	0	0	1	1	0	1	10	5	1	23
11–12	1	1	2	0	0	0	0	0	1	4	6	0	15
0– 1 p.m.	0	0	1	0	0	0	0	0	1	4	1	0	7
1– 2	3	0	0	2	1	0	0	1	1	3	4	3	18
2– 3	1	0	1	0	1	0	0	2	1	2	2	0	10
3– 4	2	1	1	0	0	1	0	0	0	2	5	3	15
4– 5	2	1	1	1	1	0	1	0	0	3	7	3	20
5– 6	2	1	1	1	1	0	1	2	0	6	3	2	20
6– 7	3	1	0	0	0	0	1	0	0	5	2	1	13
7– 8	2	1	0	1	0	0	0	2	0	10	5	2	23
8– 9	3	1	0	0	1	0	0	0	0	3	6	1	15
9–10	1	1	2	1	1	1	0	1	0	4	6	2	20
10–11	2	0	2	2	0	0	1	0	0	5	6	1	19
11–12	1	1	2	0	1	1	0	0	0	4	1	1	12
Sum.	32	17	26	15	7	6	6	13	7	150	100	37	*370

* These two hourly sums have been obtained by excluding the monthly numbers for October, on account of the Mino-Owari after shocks.

TABLE X (19).

HIKONE. DIURNAL DISTRIBUTION OF 245 EARTHQUAKES.

Jan. 1894—Dec. 1899.

All instrumentally observed.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h 0- 1 a.m.	2	0	0	2	1	0	2	0	1	0	0	1	9
1- 2	1	0	0	1	3	0	0	1	1	0	1	0	8
2- 3	1	0	1	1	0	1	0	1	0	0	0	0	5
3- 4	1	0	0	0	0	0	1	1	0	1	0	0	4
4- 5	3	1	0	2	1	1	0	2	1	0	0	4	15
5- 6	3	1	1	1	2	1	5	1	2	0	0	0	17
6- 7	1	1	3	3	1	1	1	0	0	1	2	0	14
7- 8	0	0	0	2	0	3	0	0	0	0	0	1	6
8- 9	1	0	1	1	0	2	1	1	0	1	0	1	9
9-10	2	0	2	1	1	0	1	1	0	2	0	1	11
10-11	2	1	1	0	0	1	1	1	0	0	1	0	8
11-12	2	0	0	0	1	0	0	2	1	0	6	1	13
0- 1 p.m.	1	1	1	0	1	1	0	2	0	0	0	2	9
1- 2	3	1	0	2	1	2	0	2	0	1	0	1	13
2- 3	2	1	0	0	1	1	1	1	0	2	0	0	9
3- 4	1	0	1	2	1	0	2	0	0	2	0	1	10
4- 5	1	0	0	3	1	1	1	2	0	0	0	0	9
5- 6	2	1	0	0	1	3	2	1	1	2	0	0	13
6- 7	4	0	0	1	0	0	1	0	1	1	1	0	9
7- 8	2	1	2	1	0	0	0	3	1	0	0	1	11
8- 9	2	0	0	1	0	2	0	1	1	1	1	0	9
9-10	0	2	1	0	2	2	0	1	0	1	0	0	9
10-11	4	0	0	3	0	0	2	2	0	0	1	0	12
11-12	1	2	3	0	0	2	2	2	0	0	0	1	13
Sum.	42	13	17	27	18	24	23	28	10	15	13	15	245

TABLE X (*20*).

WAKAYAMA. DIURNAL DISTRIBUTION OF 403 EARTHQUAKES.

Sept. 1879—Dec. 1899.

Instrumentally observed since Jan. 1888.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h 0– 1a.m.	2	1	1	1	0	1	0	1	0	1	2	1	**11**
1– 2	1	0	0	1	6	0	1	0	3	1	3	1	**17**
2 3	0	1	2	0	3	1	2	2	1	1	1	1	**15**
3 4	5	1	0	2	3	0	2	1	1	2	0	1	**18**
4 5	3	1	1	1	1	2	1	0	1	2	3	2	**18**
5 6	2	2	2	0	5	0	1	2	1	2	1	0	**18**
6 7	0	1	0	3	1	4	0	1	1	2	1	1	**15**
7 8	1	0	2	5	1	1	4	1	2	0	0	1	**18**
8– 9	0	0	2	1	2	2	1	3	1	0	0	1	**13**
9 10	2	1	1	2	2	1	2	1	2	1	3	0	**18**
10 11	2	1	2	1	1	0	1	2	2	0	0	1	**13**
11 12	1	0	0	1	1	2	2	1	0	0	3	3	**14**
0 1p.m.	2	0	3	1	1	0	1	4	4	2	2	1	**21**
1 2	4	2	1	4	3	0	0	1	3	0	1	1	**20**
2 - 3	0	0	0	1	1	2	1	2	1	0	0	2	**10**
3 - 4	2	1	4	0	1	1	2	1	0	2	2	0	**16**
4 - 5	0	1	5	2	1	2	3	1	1	1	2	0	**19**
5 6	2	3	7	1	1	1	3	0	1	0	3	2	**24**
6 - 7	1	0	0	1	1	3	2	1	0	1	1	0	**11**
7 8	2	0	4	2	3	3	2	0	2	0	0	2	**20**
8 - 9	1	2	1	0	2	2	2	1	1	3	0	1	**16**
9 -10	2	3	0	1	4	3	2	1	3	1	1	0	**21**
10- 11	1	4	3	5	0	1	1	1	0	6	0	1	**23**
11–12	1	0	0	2	2	0	1	0	3	2	1	2	**14**
Sum.	37	25	41	38	46	32	37	28	34	30	30	25	**403**

TABLE X (21).

HAMADA. DIURNAL DISTRIBUTION OF 30 EARTHQUAKES.

Jan. 1893—Dec. 1899.

Instrumentally observed since July 1894.

Hour. h h \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0 - 1 a.m.	0	0	0	0	0	0	0	0	0	0	0	1	1
1 - 2	0	0	0	0	0	0	0	0	0	0	0	1	1
2 - 3	0	0	0	0	0	0	0	0	0	0	0	0	0
3 - 4	0	0	0	0	0	0	0	0	0	0	1	0	1
4 - 5	0	0	0	0	0	0	0	1	0	0	0	0	1
5 - 6	0	0	0	0	0	0	0	0	0	0	0	0	0
6 - 7	0	0	0	0	0	0	0	0	0	0	0	0	0
7 - 8	0	0	0	0	0	0	0	0	0	0	0	0	0
8 - 9	0	0	0	0	0	0	0	0	0	0	0	0	0
9 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	1	0	1
11 - 12	0	0	1	0	0	0	0	0	0	2	0	0	3
0 - 1 p.m.	0	0	0	0	0	0	0	0	0	0	0	1	1
1 - 2	0	0	1	0	0	0	0	1	0	0	1	0	3
2 - 3	0	0	0	0	0	0	1	0	0	1	0	0	2
3 - 4	0	0	0	0	0	0	0	0	0	0	0	0	0
4 - 5	0	0	0	1	0	0	0	0	0	1	0	1	3
5 - 6	0	0	0	0	1	0	0	0	0	0	0	0	1
6 - 7	1	0	0	0	0	0	0	1	1	0	0	0	3
7 - 8	1	0	0	0	0	1	0	0	0	0	0	0	2
8 - 9	0	2	0	0	0	0	0	0	1	0	0	0	3
9 - 10	0	0	0	0	0	0	0	1	0	0	0	0	1
10 - 11	0	0	0	0	0	0	0	0	1	1	0	0	2
11 - 12	0	0	1	0	0	0	0	0	0	0	0	1	1
Sum.	2	2	2	1	1	1	1	4	3	5	3	5	30

TABLE X (22).

KOCHI. DIURNAL DISTRIBUTION OF 86 EARTHQUAKES.

Jan. 1883—Dec. 1899.

Instrumentally observed since Dec 1893.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h 0 - 1 a.m.	0	1	2	2	1	0	0	0	0	0	0	1	7
1 - 2	0	0	0	0	0	0	0	1	0	0	0	2	3
2 3	0	0	0	0	0	1	2	1	0	0	0	0	4
3 4	1	1	0	0	0	1	0	0	0	1	1	0	5
4 5	0	1	0	0	0	0	1	0	0	0	0	0	2
5 6	0	0	0	0	0	0	0	0	0	0	1	1	2
6 7	0	0	0	0	0	0	0	0	0	1	0	1	2
7 - 8	0	1	0	0	0	0	0	1	0	0	[illegible]	0	2
8 9	1	0	0	0	0	0	1	0	0	0	0	0	2
9 10	0	1	1	3	1	0	2	0	0	0	0	0	8
10 - 11	1	1	0	1	1	0	0	0	0	0	1	0	5
11 - 12	0	0	1	0	0	1	0	0	0	0	0	1	3
0 - 1 p.m.	0	1	0	0	0	0	0	0	1	0	1	0	3
1 - 2	0	0	1	0	0	1	0	0	0	0	0	0	2
2 - 3	0	1	1	0	0	1	0	0	0	2	1	1	7
3 - 4	0	1	0	1	0	0	0	0	0	0	0	0	2
4 - 5	0	0	0	0	0	0	0	0	0	0	0	0	0
5 - 6	0	0	0	0	0	0	0	0	0	0	0	0	0
6 - 7	0	0	0	0	0	0	0	0	1	1	0	0	2
7 - 8	3	0	2	0	0	1	0	1	0	0	0	1	6
8 - 9	0	1	1	0	0	2	0	0	0	0	1	1	6
9 - 10	0	0	0	1	0	0	1	1	2	0	0	0	5
10 - 11	0	0	0	0	0	1	0	0	0	2	0	0	3
11 - 12	0	0	1	0	1	0	0	1	1	0	1	0	5
Sum.	6	10	8	8	4	9	7	6	5	7	7	9	86

TABLE X (23).

HIROSHIMA. DIURNAL DISTRIBUTION OF 107 EARTHQUAKES.

Dec. 1884—Dec. 1899.

Instrumentally observed since Feb. 1892.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0– 1 a.m.	0	0	0	1	0	0	0	0	0	1	4	1	7
1– 2	1	1	0	0	0	0	0	0	0	0	0	3	5
2– 3	0	0	0	0	0	0	1	0	0	1	0	0	2
3– 4	2	1	0	0	0	1	0	0	0	1	1	1	7
4– 5	1	0	0	1	0	0	3	1	1	0	0	0	7
5– 6	0	0	0	0	0	0	0	0	0	0	1	0	1
6– 7	0	0	0	0	2	0	0	0	0	1	0	0	3
7– 8	0	2	0	0	1	0	0	0	0	1	2	0	6
8– 9	0	0	1	0	0	0	1	0	0	0	0	0	2
9–10	2	1	1	2	0	0	1	0	1	0	0	0	8
10 11	1	0	0	1	0	1	0	0	0	0	0	0	3
11-12	0	0	0	0	2	0	0	0	0	1	0	0	3
0– 1 p.m.	0	0	0	2	0	0	0	0	1	0	0	0	3
1– 2	0	0	1	1	0	1	0	0	0	0	1	0	4
2– 3	0	1	0	0	0	1	0	1	0	2	0	1	6
3– 4	1	0	1	1	0	0	0	1	0	1	0	0	5
4– 5	0	0	0	1	0	0	1	0	0	0	1	0	3
5– 6	1	1	1	0	1	1	0	1	0	0	0	0	6
6– 7	0	0	0	0	0	0	0	0	1	0	1	0	2
7– 8	1	0	0	0	0	0	0	0	0	0	0	1	2
8– 9	0	1	0	0	1	0	0	0	1	0	0	0	3
9–10	1	1	1	0	0	0	1	2	0	0	0	0	6
10-11	0	0	0	0	0	0	0	1	0	3	0	0	4
11-12	1	2	0	0	2	0	1	1	1	0	1	0	9
Sum.	12	11	6	10	9	5	9	8	6	12	12	7	107

TABLE X (24).

OITA. DIURNAL DISTRIBUTION OF 237 EARTHQUAKES.

Jan. 1887—Dec. 1899.

All instrumentally observed.

Hour. h h \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0 - 1 a.m.	0	0	1	1	0	1	0	0	0	1	0	0	4
1 - 2	1	0	1	0	0	1	1	0	0	1	1	2	8
2 - 3	0	1	0	0	0	0	2	1	3	0	0	1	8
3 - 4	1	0	0	2	1	0	1	0	0	0	2	1	8
4 - 5	2	0	1	1	0	1	1	0	2	0	0	0	8
5 - 6	2	2	2	0	2	0	1	2	1	0	1	1	14
6 - 7	1	2	2	0	0	0	0	0	1	1	4	2	13
7 - 8	1	1	0	2	1	2	0	1	0	5	3	0	16
8 - 9	0	0	1	0	0	0	2	3	0	0	2	2	10
9 - 10	1	4	2	1	0	0	1	0	1	2	1	2	15
10 - 11	2	2	0	4	0	1	1	1	0	1	4	0	16
11 - 12	0	0	1	1	2	1	0	1	0	1	1	2	10
0 - 1 p.m.	1	0	1	3	0	0	0	2	1	0	2	1	11
1 - 2	1	1	2	3	0	1	1	1	0	1	0	1	12
2 - 3	1	1	0	1	0	1	0	0	2	2	1	1	10
3 - 4	3	1	1	1	0	0	1	1	0	2	2	0	12
4 - 5	3	0	2	2	1	0	0	1	0	0	0	0	9
5 - 6	0	1	1	0	0	0	1	1	0	1	0	0	5
6 - 7	0	1	0	1	0	0	1	2	1	1	1	2	10
7 - 8	0	1	1	0	0	1	0	1	1	2	2	0	9
8 - 9	2	1	0	1	0	1	1	1	0	0	1	0	8
9 - 10	0	1	1	0	1	1	0	1	0	2	1	1	9
10 - 11	0	2	0	1	0	0	0	1	0	4	0	0	8
11 - 12	0	0	0	0	1	0	1	0	1	0	1	0	4
Sum.	22	22	20	25	9	12	16	21	14	27	30	19	237

TABLE X (25).

KUMAMOTO. DIURNAL DISTRIBUTION OF 1014 EARTHQUAKES.

Jan. 1890—Dec. 1899.

Instrumentally observed since Feb. 1890.

Hour. \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
h h													
0- 1 a.m.	3	2	2	4	1	5	1	11	7	2	3	2	43
1 2	3	4	0	2	2	3	2	9	3	7	3	1	39
2 3	0	1	3	0	1	1	3	7	2	2	3	1	24
3 4	6	3	2	0	1	2	0	5	3	1	3	2	28
4 5	3	5	1	0	3	1	1	6	8	5	2	2	37
5- 6	3	5	5	1	3	1	1	7	3	3	4	4	40
6 7	8	5	2	2	2	4	2	10	4	6	2	0	47
7 8	2	1	3	2	4	5	1	11	5	4	3	3	44
8- 9	5	4	2	1	3	3	0	16	6	3	4	1	48
9-10	4	1	6	6	6	2	4	12	5	8	2	4	60
10 11	3	4	6	3	5	8	2	12	4	1	2	1	51
11 12	4	4	4	7	4	3	0	2	5	3	5	2	43
0- 1 p.m.	8	4	1	7	2	3	0	9	7	2	2	3	48
1- 2	3	2	5	7	5	3	1	6	3	6	3	2	46
2- 3	1	2	6	5	3	4	2	7	6	6	3	6	51
3- 4	2	1	1	3	5	6	2	11	7	3	5	3	49
4- 5	1	3	5	5	3	3	5	6	3	3	0	2	39
5- 6	3	4	2	2	5	2	1	3	3	2	0	3	30
6- 7	3	2	4	2	2	1	1	9	6	4	2	0	36
7- 8	4	4	1	0	5	2	0	7	4	6	4	1	38
8- 9	2	2	3	3	3	0	2	5	3	1	3	4	31
9-10	4	3	3	3	4	5	2	9	4	4	7	2	50
10-11	4	0	2	2	4	3	2	8	4	4	4	2	39
11-12	3	2	5	3	4	3	2	15	7	2	6	1	53
Sum.	82	68	74	70	80	73	37	203	112	88	75	52	1014

TABLE X (26).

KAGOSHIMA. DIURNAL DISTRIBUTION OF 704 EARTHQUAKES.

March. 1885—Dec. 1899.

Instrumentally observed since Nov. 1887

Hour. (h – h) \ Month.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Sum.
0 - 1 a.m.	1	3	2	2	1	1	1	1	2	2	1	0	17
1 2	4	1	1	2	0	1	0	3	2	1	1	5	21
2 - 3	1	0	1	0	1	0	1	0	4	3	1	2	14
3 4	2	0	0	1	2	1	0	0	4	0	0	1	11
4 - 5	2	2	0	1	1	0	1	0	2	0	0	0	9
5 6	0	0	1	6	0	1	0	0	0	3	2	0	13
6 7	2	2	0	0	2	5	0	0	1	3	1	1	17
7 8	2	1	0	0	1	1	2	1	3	3	1	1	16
8 9	0	1	1	4	0	0	0	1	3	1	0	0	11
9 10	4	3	4	1	0	2	0	1	0	1	2	0	18
10 - 11	4	2	0	6	0	0	2	3	0	0	1	1	19
11 12	1	2	2	1	3	2	0	1	3	0	2	0	17
0 1 p.m.	0	1	0	0	2	0	2	2	2	3	2	1	15
1 2	5	2	2	4	3	4	2	0	1	5	2	1	31
2 - 3	1	1	1	1	3	2	2	2	3	0	1	1	18
3 4	2	1	1	1	1	0	0	2	3	3	1	2	17
4 5	1	2	1	3	1	1	0	3	2	0	0	2	16
5 - 6	3	2	5	3	1	1	0	0	2	2	1	2	22
6 7	2	0	2	1	0	1	1	2	2	1	1	3	16
7 - 8	0	1	2	3	3	0	2	0	3	4	0	1	19
8 - 9	2	2	2	1	3	1	1	1	2	0	1	0	16
9 - 10	1	2	0	2	2	0	3	2	2	1	1	1	17
10 - 11	5	1	0	4	0	1	0	1	1	3	3	3	22
11 - 12	0	2	0	3	0	0	1	1	2	2	1	0	12
Sum.	45	34	28	50	30	25	21	27	49	41	26	28	404

16. *Diurnal seismic variation.* **As examples, I give in Fig. 13 (1a, 2a, 3a) a graphical representation of the hourly distribution of earthquakes for *Tokyo*, *Nemuro* and *Kumamoto*. It will be seen that the curves, though apparently very irregular, are still subject to certain laws.**

***Tokyo*. Fig. 13 (1, *a*).** The curve of the diurnal seismic variation, constructed from 2208 earthquakes instrumentally observed during 24 years, 1876 to 1899, indicates two nearly equal maxima *a* and *b*: *a* (=113) occurs between 9 and 10 a.m., while *b* (=107) occurs between 10 and 11 p.m. The time interval between these two maxima is about 12 hours. Again there are two sub-maxima *c* and *d*: *c* (=90) occurs between 2 and 3 a.m., while *d* (=104) occurs between 3 and 4 p.m., the time interval between these two sub-maxima being also about 12 hours. Thus the curve indicates, on the whole, four maxima, with an average time interval of 6 hours. Corresponding to the maxima *a* and *b*, there are two minima *a'* and *b'*: *a'* (=71) occurs between 4 and 5 a.m., while *b'* (=81) occurs between 5 and 6 p.m.; the time interval between the two being about 12 hours. Again, corresponding to the two maxima *c* and *d*, there are two minima *c'* and *d'*: *c'* (=81) occurs between 1 and 2 a.m., while *d'* (=79) occurs between 0 and 1 p.m.; the time interval between the two being also about 12 hours. The difference between *a* and *a'* is 42, while that between *b* and *b'* is 26; these values being respectively 46% and 28% of the mean hourly-earthquake number, namely 92.

***Nemuro*. Fig. 13 (2, *a*).** The total number of earthquakes observed instrumentally at *Nemuro* between March 23rd 1894 and Dec. 31st 1899 is 991 The diurnal distribution gives the mean hourly number of 41,3. (See Table X (1).) The curve of the hourly seismic frequency indicates the absolute *maxima* *b* (=53) between 11 a.m. and noon, and the absolute minimum *b'* (=25) between 2 and 3 p.m.; the difference between *b* and *b'*, which is=28, being 68% of the mean hourly earthquake number. The form of the curve is neither regular nor simple, but from the mean dotted curve we see that there are three maxima *a*, *b* and *c*, indicating the 8 hours period. Corresponding to these maxima, there are three minima *a'*, *b'* and *c'*.

Kumamoto. Fig. 13 (3, *a*). In *Kumamoto* 1014 earthquakes were observed, instrumentally for the most part, between January 1890 and Dec. 1899; their diurnal distribution giving a mean hourly number of 42.2. (See Table X (25).) The curve of the hourly seismic frequency indicates two well defined maxima a and b: a (=60) occurs between 9 and 10 a.m., while b (=50) occurs between 9 and 10 p.m.; the time interval between the two being exactly 12 hours. Corresponding to the two maxima, there are two minima a' and b': a' (=24) occurs between 2 and 3 a.m., while b' (=30) occurs between 5 and 6 p.m. The difference between a and a', which amounts to 36, is 80% of the mean hourly earthquake number.

17. *Hours of occurrence of the absolute maxima and minima.* Table XI gives for the different stations the hours of occurrence of the absolute maxima and minima in the diurnal variation of seismic frequency.

TABLE XI.

HOURS OF OCCURRENCE OF THE ABSOLUTE MAXIMUM AND MINIMUM IN THE DIURNAL SEISMIC VARIATION.

Stations.	Hours of occurrence of	
	Maximum.	Minimum.
Nemuro.	11 a.m.–noon.	2- 3, p.m.
Miyako.	5- 6, p.m.	2- 3, p.m.
Ishinomaki.	2- 3, p.m.	0- 1, a.m.
Fukushima.	9–10, p.m.	4- 5, a.m.
Utsunomiya.	6- 7, a.m.	11 p.m.–Midnight.
Tokyo.	9–10, a.m.	4- 5, p.m.
Nagoya.	1- 2, a.m.	0- 1, p.m. 6- 7, p.m.
Gifu.	10–11, p.m.	4- 5, p.m.
Tsu.	10–11, a.m. 7- 8, p.m.	0- 1, p.m.
Wakayama.	5- 6, p.m.	2- 3, p.m.
Kumamoto.	9–10, a.m.	2- 3, a.m.
Kagoshima.	1- 2, p.m.	4- 5, a.m.

Table XI contains only those stations, for each of which the number of earthquakes observed was greater than 400. From this table, it will be seen that the hours of occurrence of the absolute maxima and minima in the diurnal seismic variation are very different for the different places. This may partly be due to the fact that earthquakes observed at some of the stations are not sufficiently numerous. The probable cause is, however, the predominance of different periodicities at the different stations. (See next §.)

18. *Periodicities in the diurnal seismic variation.* From the existence o. the diurnal period, which in the cases of Tokyo, Nemuro and Kumamoto, as above exemplified, is well pronounced, we may expect for some places to find the harmonics or 12, 8, 6 .... hours periods in the diurnal seismic variation. But, as one or other of these various periods may predominate at each place, we may reasonably suppose the diurnal variation of seismic frequency to be a good deal different for the different stations. Hence also the maxima and minima may occur in different hours at the latter.

The diurnal seismic variations at the 12 stations contained in Table XI, namely, Nemuro, Miyako, Ishinomaki, Fukushima, Utsunomiya, Tokyo, Nagoya, Gifu, Tsu, Wakayama, Kumamoto and Kagoshima, are graphically shown in Fig. 13 (1 3) and Fig. 14 (1 3), from which it will be seen that these stations can be divided into four different groups, as follows.—

(1). *Stations with 12 hours period.* This group includes Fukushima, Utsunomiya, Wakayama and Kumamoto. (See Fig. 14 (1) and Fig. 13 (3).) The hours of occurrence of the two maxima and two minima are given in the following table.

Station. / Max. or Min.	Fukushima.	Utsunomiya.	Wakayama.	Kumamoto.
1st Max.	9-10, a.m.	9-10, a.m.	4- 5, a.m.	9-10, a.m.
2nd „	8- 9, p.m.	8- 9, p.m.	5- 6, p.m.	9-10, p.m.
1st Min.	2- 3, a.m.	2- 3, a.m.	0- 1, a.m.	2- 3, a.m.
2nd „	at 2, p.m.	3- 4, p.m.	10-11, p.m.	6- 7, p.m.

Utsunomiya shows, like Tokyo, besides the two principal maxima *a* and *b*, two sub-maxima *c* and *d*; so that in this case there exists also the 6 hours period. It will be seen that on the whole the hours of occurrence of the maxima are approximately the same for all the four stations.

(2). *Stations with 8 hours period.* This group includes Nemuro, Miyako, Gifu and Tsu. (See Fig. 13 (2) and Fig. 14 (2).) The hours of occurrence of the 3 maxima and 3 minima are given in the following table.—

Station. / Max. or Min.	Nemuro.	Miyako.	Gifu.	Tsu.
1st max.	at 4 a.m.	1- 2, a.m.	4- 5, a.m.	2- 3, a.m.
2nd ,,	11a.m.-noon.	9-10, a.m.	0- 1, p.m.	10-11, a.m.
3rd ,,	5- 7, p.m.	6 7, p.m.	at 9 p.m.	7- 8, p.m.
1st Min.	8- 9, a.m.	at 5 a.m.	9-10, a.m.	at 7 a.m.
2nd ,,	2- 3, p.m.	at 2 p.m.	3- 4, p.m.	1- 2, p.m.
3rd ,,	10-11, p.m.	at 11, p.m.	10-11, p.m.	0- 1, a.m.

Thus the hours of occurrence of the maxima and minima are approximately constant for the four stations. Further, the 2nd minimum and the 2nd maximum for the stations of Group (1) occur roughly in the same hours as the 2nd minimum and the 3rd maximum for the stations of this group.

(3). *Station with 6 hours period.* The only well defined example of this class is Tokyo, the hours of occurrence of the maxima and minima being as follows.—

1st Max.	2– 3, a.m.	1st Min.	1– 2, a.m.
2nd ,, ...	9–10, a.m.	2nd ,, ...	4 5, a.m.
3rd ,, ...	3– 4, p.m.	3rd ,, ...	0– 1, p.m.
4th ,, ...	9–10, p.m.	4th ,, ...	5- 6, p.m.

The 2nd and 4th maxima for Tokyo thus occur approximately in the same hours as the 1st and 2nd maxima for the stations of group (1).

(4). *Stations with 4 hours period.* This group includes Ishinomaki, Nagoya and Kagoshima, the diurnal variation at each of these places showing 6 maxima and 6 minima. The curve for Nagoya is somewhat

irregular, but those for Ishinomaki and Kagoshima are much similar to one another:

From what has been said above it seems that the diurnal variation is different for the different places; the maxima and minima belonging to one and the same periodicity, however, having a tendency to occur at the different places simultaneously.

19. *Amount of the diurnal seismic variation.* Table XII gives the 3-hourly distribution of the earthquakes; while Table XIII gives the hourly and 3 hourly maximum and minimum earthquake numbers, their difference and mean, and the amount of the fluctuation expressed in percentage.*

---

* In Table XIII, Sapporo and other 14 stations, whose earthquake number is less than 400, have been excluded from the list of hourly distribution; similarly the three stations of Hamamatsu, Hamada and Kochi, whose earthquake number is less than 100, have been excluded from the list of 3-hourly distribution.

TABLE XII.

DIURNAL VARIATION OF SEISMIC FREQUENCY: 3-HOURLY EARTHQUAKE NUMBERS AT THE DIFFERENT STATIONS.

Hour-interval. / Station.	a.m. 0-3	a.m. 3-6	a.m. 6-9	a.m. 9-12	p.m. 0-3	p.m. 3-6	p.m. 6-9	p.m. 9-12	Sum.
Nemuro	119	148	138	133	92	131	122	108	991
Sapporo	20	22	16	16	12	21	20	26	153
Hakodate	44	35	27	30	38	38	48	41	301
Akita	40	44	36	41	36	* 44	* 55	44	*340
Miyako	90	69	82	99	78	103	107	76	704
Yamagata	24	16	26	29	22	30	34	16	197
Ishinomaki ...	98	107	109	133	185	146	141	115	1034
Fukushima	90	98	110	113	104	103	137	102	857
Utsunomiya ..	47	53	71	75	66	53	71	56	492
Tokyo	263	243	283	290	255	282	286	306	2208
Maebashi	14	13	17	17	15	17	17	16	126
Niigata	19	23	25	32	15	32	35	35	216
Nagano	32	30	29	44	36	56	38	42	307
Numazu	23	13	21	17	23	14	23	28	162
Hamamatsu ...	13	7	13	12	12	15	12	15	99
Nagoya	312	286	203	206	190	215	197	245	1854
Gifu	525	566	486	451	488	442	585	570	4113
Tsu	50	39	* 38	51	35	55	51	51	*370
Hikone	22	36	29	32	31	32	29	34	245
Wakayama	43	54	46	45	51	59	47	58	403
Hamada	2	2	0	4	6	4	8	4	30
Kochi	14	9	6	16	12	2	14	13	86
Hiroshima	14	15	11	14	13	14	7	19	107
Oita	20	30	39	41	33	26	27	21	237
Kumamoto	106	105	139	154	145	118	105	142	1014
Kagoshima	52	33	44	54	64	55	51	51	404
Sum.	2096	2096	2044	2149	2057	2107	2267	2234	17050

The numbers marked with (*) are the *modified numbers*. (Table XIII.)

TABLE XIII.

DIURNAL VARIATION OF SEISMIC FREQUENCY.

f = Mean hourly eqke number

g = Difference between the max. and min. hourly eqke numbers.

$h = \frac{g}{f}$ = Diurnal fluctuation of the hourly seismic frequency, in %.

F = Mean 3-hourly eqke number.

G = Difference between the max. and min. 3-hourly eqke numbers.

$H = \frac{G}{F}$ = Diurnal fluctuation of the 3-hourly seismic frequency, in %.

Station.	Hourly distribution.					3-hourly distribution.				
	Max number.	Min. number.	f	g	h%	Max. number.	Min. number.	F	G	H%
Nemuro	53	25	41.3	28	68	148	92	123.9	56	45
Sapporo						26	12	19.1	14	73
Hakodate						48	27	37.6	21	56
Akita						55	36	42.5	19	45
Miyako	42	18	29.3	24	82	107	69	88.0	38	43
Yamagata						34	16	24.6	18	73
Ishinomaki	90	23	42.1	67	159	185	98	129.2	87	67
Fukushima	50	23	35.7	27	76	137	90	107.1	47	44
Utsunomiya	30	12	20.5	18	88	75	47	61.5	28	46
Tokyo	113	71	92.0	42	46	306	243	276.0	63	23
Maebashi						17	13	15.7	4	25
Niigata						35	15	27.0	20	74
Nagano						56	29	38.4	27	70
Numazu						28	13	20.2	15	74
Hamamatsu										
Nagoya	117	55	77.2	62	80	312	190	231.7	122	53
Gifu	219	138	171.4	81	47	585	442	514.1	143	28
Tsu	23	7	15.4	16	104	55	35	46.2	20	43
Hikone						36	22	40.6	14	34
Wakayama	24	10	16.7	14	84	59	43	50.4	16	32
Hamada										
Kochi										
Hiroshima						19	7	13.4	12	90
Ōita						41	20	29.6	21	71
Kumamoto	60	24	42.2	36	85	154	105	126.7	49	39
Kagoshima	31	9	16.8	22	131	64	33	50.5	31	61
* *Mean*					85					52

According to Table XIII, the fluctuation of the hourly earthquake number (h) varies between 46 and 159% and has a mean value of 85%. Again, the fluctuation of the 3-hourly earthquake number (H) varies between 23 and 90% and has a mean value of 52%. (In deducing these means, the weight of the results relating to the different stations is taken as 2 when the earthquake number is above 500, and as 1 when it is below 500.)

20. *Cause of the diurnal variation of seismic frequency.* The principal cause which produces the diurnal variation of seismic frequency is probably the atmospheric pressure. For the sake of reference I give in Table XIV the mean hourly barometric pressures observed at Kumamoto and other 9 *first class* meteorological observatories.*

---

* Table XIV is extracted from the *Climate of Japan*, published by the central Meteorological Observatory. A *first class* meteorological observatory is one, which makes *hourly* meteorological observations.

TABLE XIV.

DIURNAL VARIATION OF BAROMETRIC PRESSURE.

700 mm +

Station. / Hour.	Kuma-moto.	Matsu-yama.	Hiro-shima.	Osaka.	Waka-yama.	Nagano.	Tokyo.	Hako-date.	Sapporo.	Nemuro.	*Mean.**
1 a.m.	62.49	59.15	62.28	62.05	61.18	24.50	59.33	60.01	58.19	57.14	60.20
2	62.41	59.07	62.21	61.98	61.07	24.45	59.24	59.96	58.15	57.08	60.13
3	62.31	58.99	62.12	61.89	60.99	24.40	59.18	59.86	58.09	57.03	60.05
4	62.26	58.92	62.09	61.88	60.98	24.43	59.21	59.86	58.10	57.09	60.04
5	62.30	59.02	62.19	61.97	61.06	24.54	59.35	59.95	58.17	57.19	60.13
6	62.43	59.18	62.37	62.14	61.23	24.73	59.58	60.04	58.25	57.31	60.28
7	62.65	59.42	62.61	62.35	61.45	24.93	59.79	60.15	58.35	57.43	60.47
8	62.82	59.60	62.78	62.50	61.61	25.03	59.95	60.22	58.38	57.48	60.59
9	62.91	59.69	62.86	62.60	61.69	25.04	60.00	60.22	58.34	57.50	60.65
10	62.91	59.67	62.78	62.52	61.65	24.85	59.88	60.14	58.24	57.37	60.57
11	62.69	59.45	62.51	62.27	61.42	24.48	59.49	59.92	57.99	57.10	60.32
Noon.	62.30	59.05	62.05	61.84	61.00	23.98	58.98	59.59	57.69	56.81	59.92
1 p.m.	61.86	58.65	61.59	61.40	60.60	23.54	58.56	59.36	57.47	56.61	59.57
2	61.53	58.42	61.30	61.13	60.31	23.33	58.31	59.25	57.40	56.56	59.36
3	61.34	58.27	61.14	61.02	60.18	23.32	58.27	59.31	57.46	56.63	59.29
4	61.32	58.27	61.15	61.04	60.18	23.40	58.33	59.41	57.58	56.72	59.33
5	61.44	58.37	61.27	61.13	60.27	23.59	58.52	59.56	57.72	56.87	59.46
6	61.66	58.57	61.51	61.36	60.48	23.89	58.82	59.76	57.93	57.06	59.68
7	61.97	58.82	61.82	61.65	60.77	24.20	59.14	59.98	58.12	57.22	59.94
8	62.29	59.07	62.12	61.93	61.05	24.47	59.40	60.16	58.30	57.38	60.19
9	62.51	59.30	62.32	62.14	61.27	24.61	59.60	60.22	58.39	57.42	60.35
10	62.66	59.39	62.48	62.23	61.37	24.67	59.61	60.22	58.37	57.38	60.41
11	62.66	59.37	62.46	62.21	61.35	24.63	59.54	60.17	58.32	57.30	60.38
Mid-night.	62.58	59.26	62.38	62.12	61.25	24.57	59.43	60.08	58.23	57.19	60.28
Mean.	62.26	59.04	62.10	61.89	61.02	24.32	59.23	59.89	58.05	57.12	60.07

* Nagano excepted.

To see the relation between the diurnal variation of seismic frequency and that of barometric pressure, I give in Fig. 13 (1–3) as examples, a graphical representation of the variation of the barometric pressure and the 3 hourly earthquake numbers at *Tokyo*, *Nemuro* and *Kumamoto*.

Tokyo. Fig. 13 (1). The curve of the 3-hourly earthquake number indicates two maxima *A* and *B* and two minima *A'* and *B*,' while the curve of the barometric pressure indicates also two maxima *C* and *D* and two minima *C'* and *D*.' The forms of the two curves are very much similar and parallel to one another, the maxima and minima occurring at almost the same hours for both. Thus, the maximum barometric pressure appear at 9 a.m. and between 9 and 10 p.m., while the maximum seismic frequency occurs between 9 and 10 a.m. and between 9 and 10 p.m. Again the minimum barometric pressure occurs at 3 a.m. and at 3 p.m., while the minimum seismic frequency also occurs at about the same hours.

Nemuro. Fig. 13 (2). The variations of the seismic frequency and of the barometric pressure show each two maxima and two minima; the forms of the two curves being similar to each other. The absolute minimum of the barometric curve occurs at 2 p.m., while that of the seismic curve also occurs between 1 and 2 p.m.

Kumamoto. Fig. 13 (3). The variations of the seismic frequency and that of the barometric pressure show each two maxima and two minima; the forms of the two curves being similar to each other. Thus the two maxima of the barometric curve, *C* and *D*, occur respectively between 9 and 10 a.m. and between 10 and 11 p.m., while the maxima of the seismic curve also occur respectively between 9 and 10 a.m. and between 9 and 10 p.m. Further, one of the barometric minima occurs at about 4 a.m., while one of the seismic minima occurs also at about the same hour, namely, between 2 and 3 a.m.

From these examples we cannot but conclude that the diurnal variation of seismic frequency is caused, mainly at least, by that of the atmospheric pressure. To see more generally the diurnal seismic

variation for the whole of Japan, I give in Table XV a modification of the data contained in Table XIII, namely the 3-hourly earthquake frequencies, expressed in percentages, for the 26 different stations; the total diurnal seismic frequency for each of the latter being taken as 100%. The figures in the last column, (S), are the total numbers of the earthquakes taken account of in the construction of the table; and the mean values of the frequencies given at the bottom row have been calculated by supposing the weight of the results for the stations with $S > 500$ to be double that of the results for the stations with $S < 500$.

TABLE XV.

DIURNAL VARIATION OF SEISMIC FREQUENCY.

The (3-hourly) frequency has been obtained by multiplying the actual earthquake number with the factor $\frac{1000}{S}$, where S denotes the total earthquake number at a given station.

Time-interval. / Station.	0–3 a.m.	3–6 a.m.	6–9 a.m.	9–12 a.m.	0–3 p.m.	3–6 p.m.	6–9 p.m.	6–12 p.m.
Nemuro*	120	149	139	134	93	132	123	109
Sapporo	131	144	105	105	78	137	131	170
Hakodate*	146	116	90	100	126	126	159	136
Akita*	118	129	106	121	106	129	162	129
Miyako*	128	98	116	141	111	146	152	108
Yamagata	122	81	132	147	112	152	173	81
Ishinomaki*	95	103	105	129	179	141	136	111
Fukushima*	105	115	129	132	122	121	160	119
Utsunomiya*	95	108	144	152	134	108	144	114
Tokyo*	119	110	128	131	116	128	130	139
Maebashi	111	103	135	135	119	135	135	127
Niigata*	88	106	116	148	69	148	162	162
Nagano*	104	98	95	143	117	183	124	137
Numazu	142	80	130	105	142	86	142	173
Hamamatsu	131	71	131	121	121	152	121	152
Nagoya*	168	154	109	111	102	116	106	132
Gifu*	128	138	118	110	119	107	142	139
Tsu*	135	105	103	138	95	149	138	138
Hikone*	90	145	118	131	126	131	118	139
Wakayama*	107	134	114	112	126	146	117	144
Hamada	67	67	0	133	200	133	266	133
Kōchi	162	104	70	186	139	23	162	151
Hiroshima	131	140	103	131	122	131	65	178
Ōita*	84	127	165	173	139	110	114	89
Kumamoto*	105	104	137	152	143	116	104	140
Kagoshima*	129	82	109	134	159	136	126	126
Sum.	3061	2911	2947	3455	3215	3322	3612	3476
Mean.	116,2	116,8	119,2	131,9	120,4	131,4	133,7	130,5

* The asterisks mark those stations whose S or total actual number of earthquakes, i greater than 200. In the deduction of the *Mean* frequency, I have excluded the three statior of Hamamatsu, Hamada and Kochi, whose S is less than 100.

The upper curve in Fig. 15 has been drawn from the average values of the 3-hourly seismic frequencies as given at the bottom row of Table XV, and represents the diurnal seismic variation for the whole of Japan. The lower curve in the same figure is given for the sake of comparison and represents the diurnal variation of the barometric pressure, so to speak, for the whole of Japan, the ordinate being the mean hourly barometric height from Kumamoto and 9 other *first class* meteorological observatories, given in Table XIV.

It will be seen that the seismic curve is much similar to the barometric curve, each indicating two maxima and two minima, which occur in about the same hours of the day for both. Thus, in the seismic curve the two maxima occur respectively between 10 and 11 a.m. and between 7 and 8 p.m., and the two minima respectively at about 4 a.m. and between 1 and 2 p.m. In the case of the barometric curve, the two maxima occur respectively at 9 a.m. and at 10 p.m., and the two minima respectively at 4 a.m. and at 3 p.m. The similarity of the seismic curve to the barometric one must be regarded as being sufficiently close as we can expect, considering the complicated nature of the problem and particularly the presence of the harmonics of the diurnal period in the seismic variation.

From Tables XIII and XV we see that the maximum, minimum and mean values are, for the average hourly barometric pressure, respectively, 760.65, 759.29 and 760.07 mm; and, for the 3-hourly seismic frequency (Table XV) respectively 133.7, 116.2 and 125.0. These give the fluctuations respectively of 0.18% and 14%.

21. *Remarks on the annual and diurnal seismic variations.* As stated in § 14 the annual frequency variation of the (*A*) region which originate mostly inland, follows that of the barometric pressure; while, with the (*B*) region earthquakes, which originate mostly under the ocean, the reverse is the case. In the diurnal seismic variation, however, no such peculiarity is to be found whether the origins of earthquakes be inland or suboceanic. Thus, for example, the diurnal seismic variation at *Nemuro, Miyako, Fukushima, Utsunomiya, Tokyo, Gifu, Nagoya, Tsu* and *Kumamoto*

more or less similar to the barometric diurnal variation, although the first four of these stations belong to the (*B*) region and the remaining five belong to the (*A*) region. This fact may appear to present a contradiction to what has been said respecting the barometric pressure, as explained in § 12–14. We are not, however, at all justified to infer simply from the dependence of the annual seismic variation on the geographical position the existence of any similar relation in the case of the diurnal variations. In fact, to base conclusions on certain phenomena from the mere analogy of some apparently similar or allied ones is a thing which requires the utmost precaution. As an example, I may refer to the difference between the annual variation of destructive earthquakes and that of ordinary small ones,* and to the non-uniformity of the annual seismic variation in the different parts of Japan (§ 7). Turning now to barometric pressure, we see that the diurnal variation in Japan itself is similar to that on the northern Pacific; the only difference being that the amplitude of the variation is smaller for the latter than for the former. This fact will cause the diurnal variation of seismic frequency to be in the main similar to that of barometric pressure, irrespective to the origins of the earthquakes.

22. *Conclusion.* According to what has been said thus far the seismic frequency seems to have a close relation to the atmospheric pressure. It is, however, to be noted that *single* barometric fluctuations, which, during storms, may sometimes amount to 20 mm or more, are in general not accompanied or immediately followed by any marked increase of seismic frequency. This fact was, amongst others, found to be the case with the numerous after-shocks of the great Mino-Owari earthquake of Oct. 28th 1891.† On the other hand, the annual and diurnal (and possibly some other) variations of the atmospheric pressure, Although the

---

* See my *Notes on the Earthquake Investigation Committee Catalogue of Japanese Earthquakes,* Jour. Sc. Coll. Imp. Univ., Tokyo, Vol. XI.

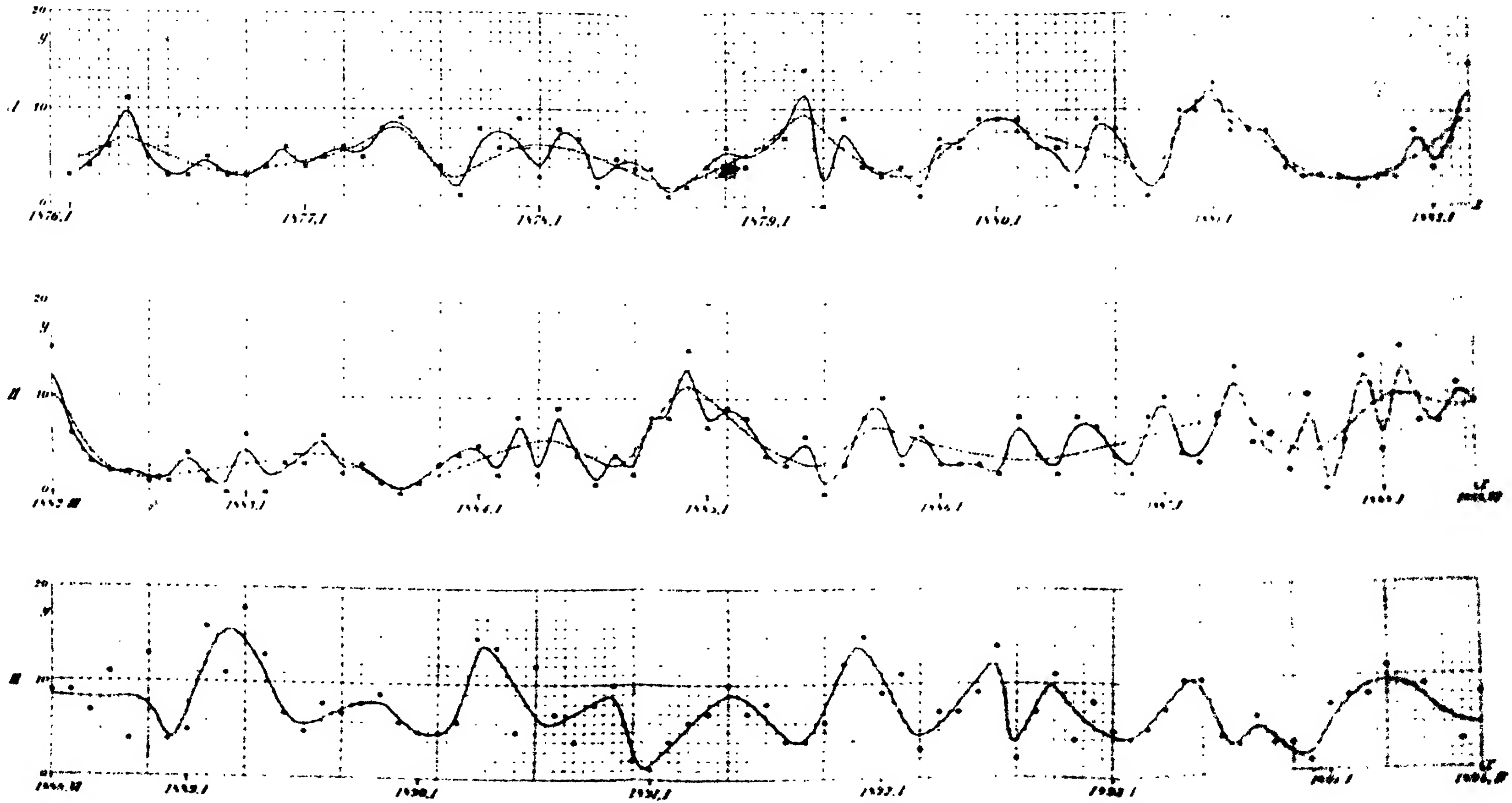
† In the case of the *underground sounds* at Arima, however, the frequency seemed to follow, in some instances at least, barometric changes.

absolute amount is not very great, continue for ever and consequently may be supposed to be capable of producing corresponding oscillations or periodic variations in the stresses existing in the earth's crust.

I have here confined myself to the general consideration of the annual and diurnal seismic variations in Japan, the investigation of other periodicities being reserved to a future occasion.

Feb. 25th, 1900. Tokyo.

Fig. 1. Variation of Seismic Frequency at *Tokyo*
(Jan. 1876—Sept. 1894.)



X = Time in years and months y = Monthly earthquake number at Tokyo

I is continued to II, and II is continued to III
The dotted curves in I and II indicate the annual period
III indicates principally the semi-annual period.

Fig. 1. (Cont.) IV. Variation of Seismic Frequency at Tokyo.

(Sept. 18[illegible]—Dec. 1899.)

The dotted curve indicates the *Annual period*.

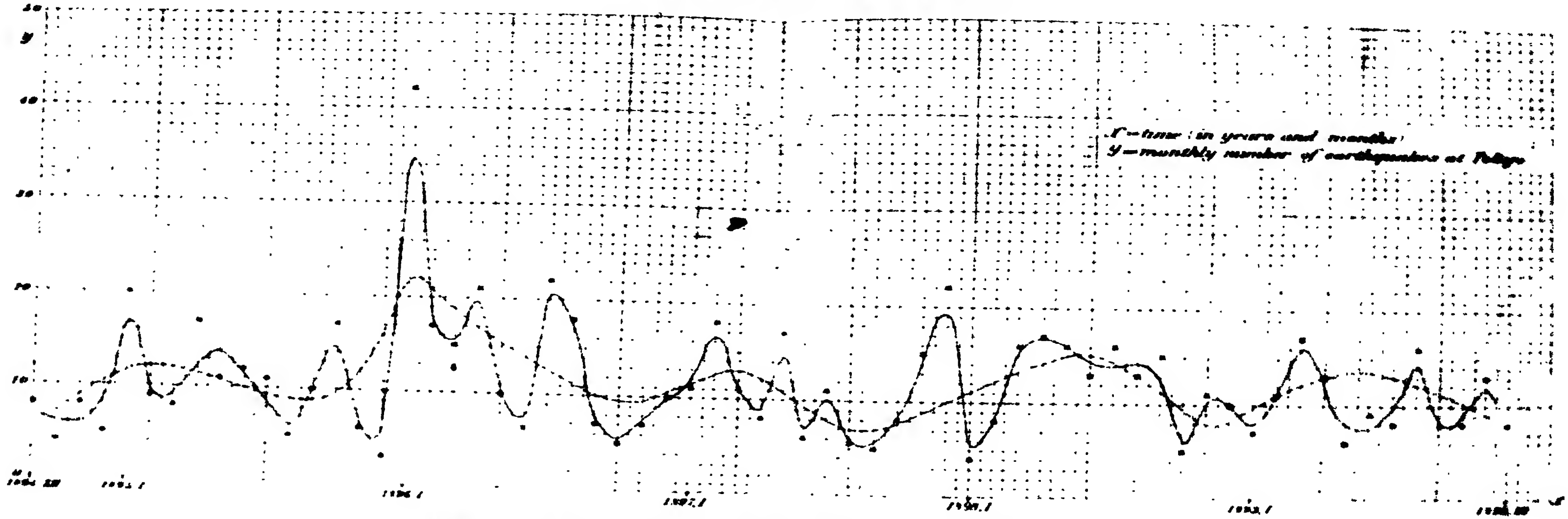


Fig. 2. Variation of Seismic Frequency and Barometric Pressure at Tokyo

(Jan. Feb. 1876 – Nov. Dec. 1885.)

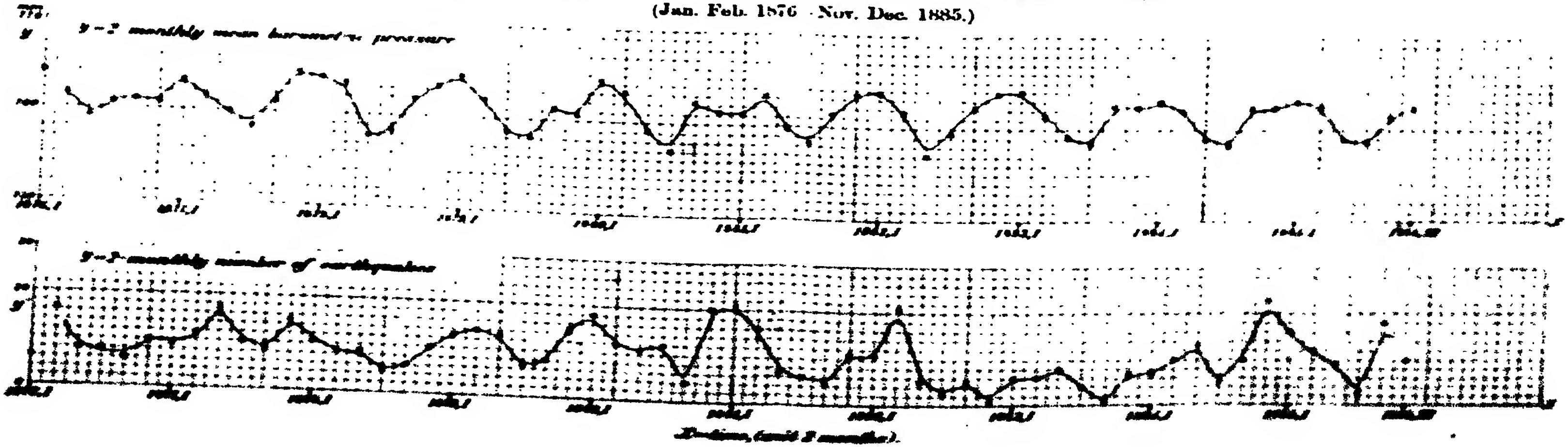


Fig. 3. Variation of Seismic Frequency at *Nemuro*, *Gifu* and *Nagoya*.

(1894—1899.)

x = time, in months.
y = monthly number of earthquakes.

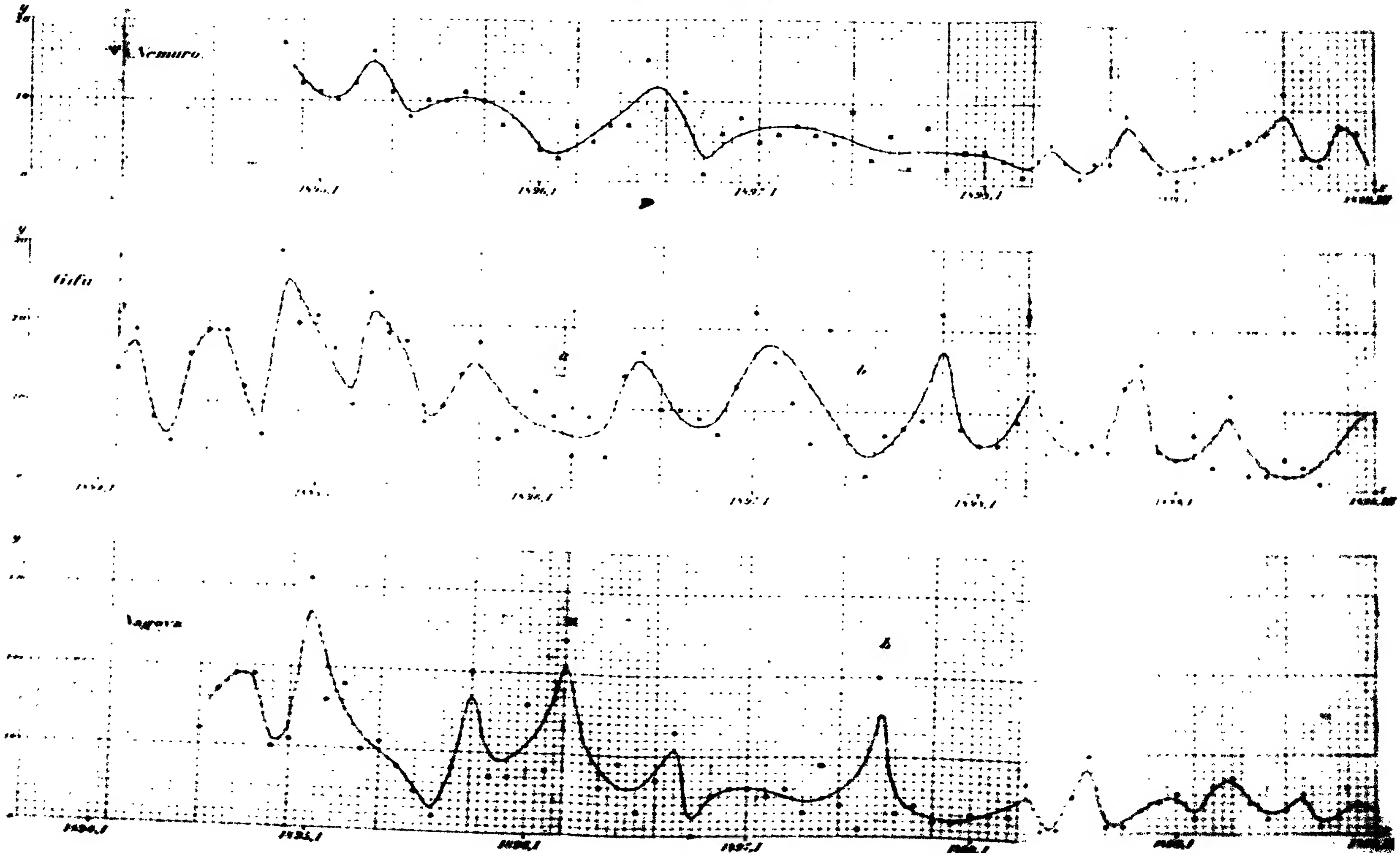
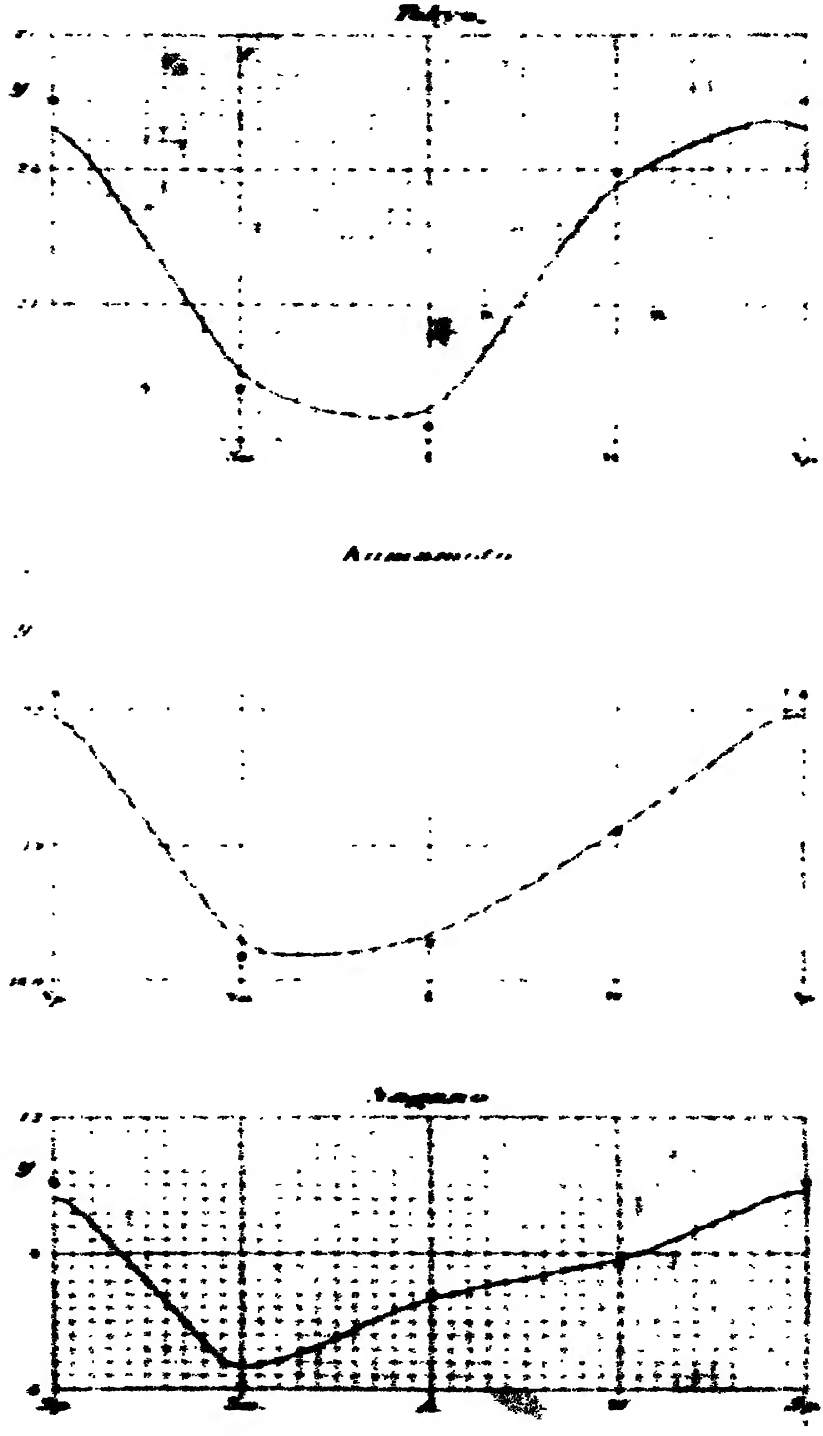
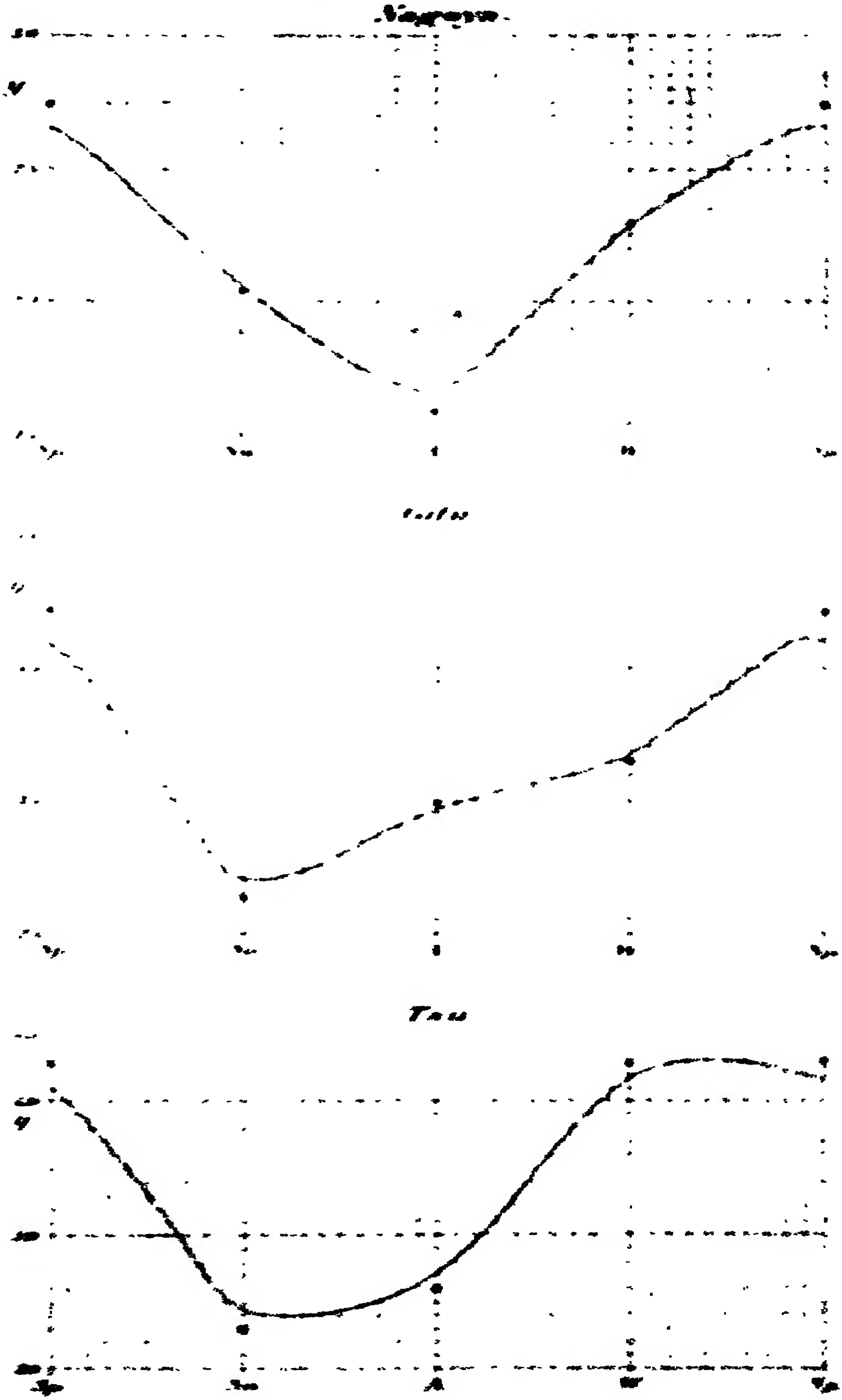


Fig. 4, (1). Seasonal Variation of Seismic Frequency.
Tokyo, Kumamoto and Nagano.



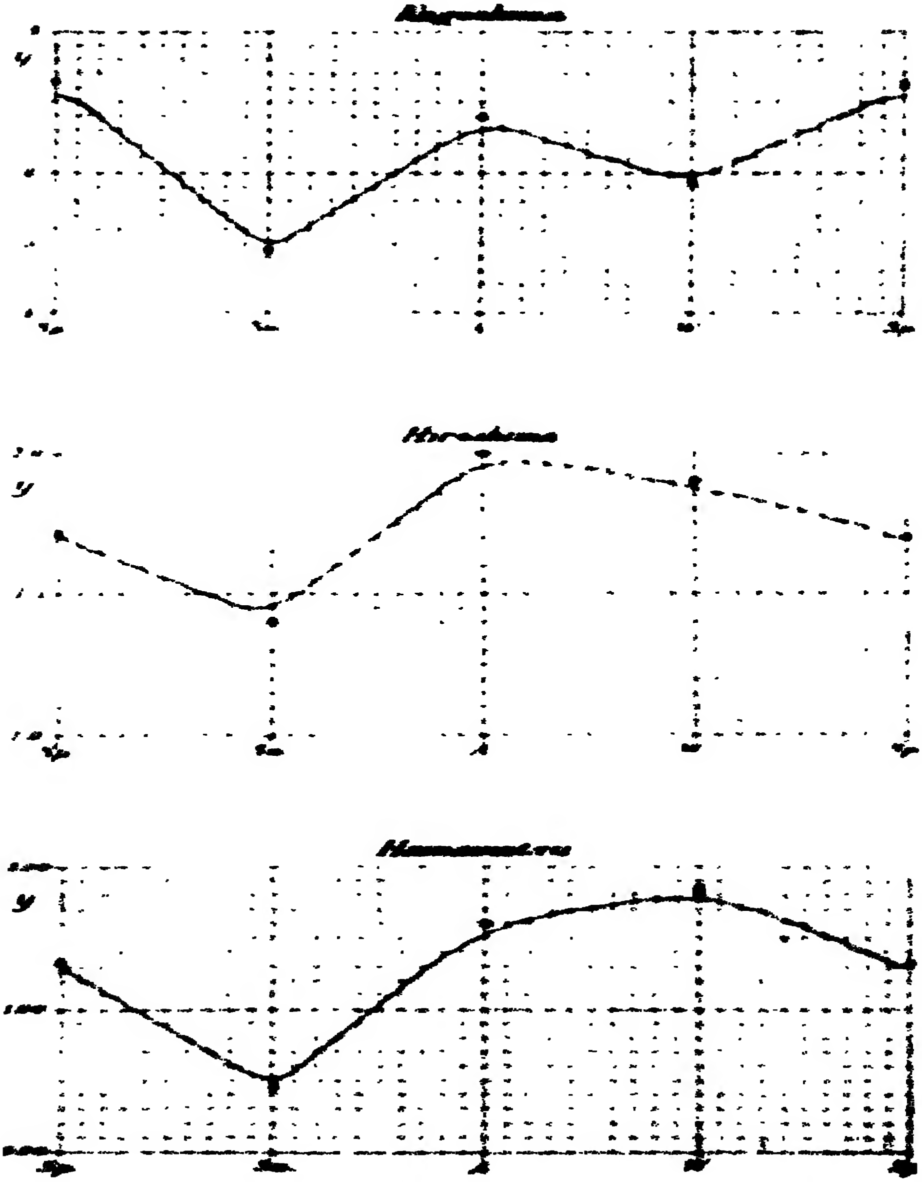
y = mean annual number of earthquakes

Fig. 4, (2). Seasonal Variation of Seismic Frequency.
***Nagoya, Gifu* and *Tsu*.**



y = mean seasonal number of earthquakes.

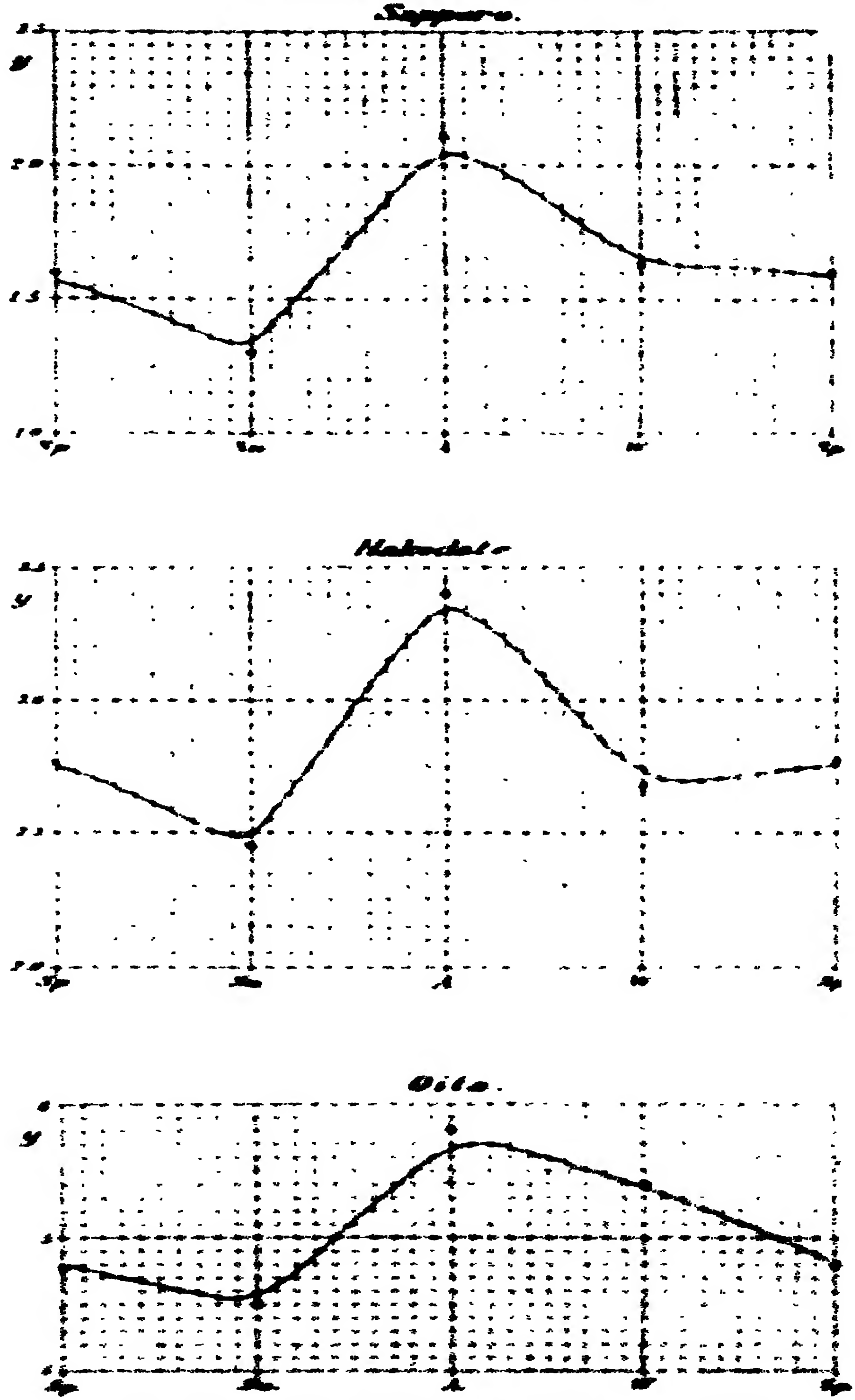
Fig. 4, (4). Seasonal Variation of Seismic Frequency.
Kagoshima, Hiroshima, and Hamamatsu.



y = mean monthly number of earthquakes.

Fig. 4, (5). **Seasonal Variation of Seismic Frequency.**

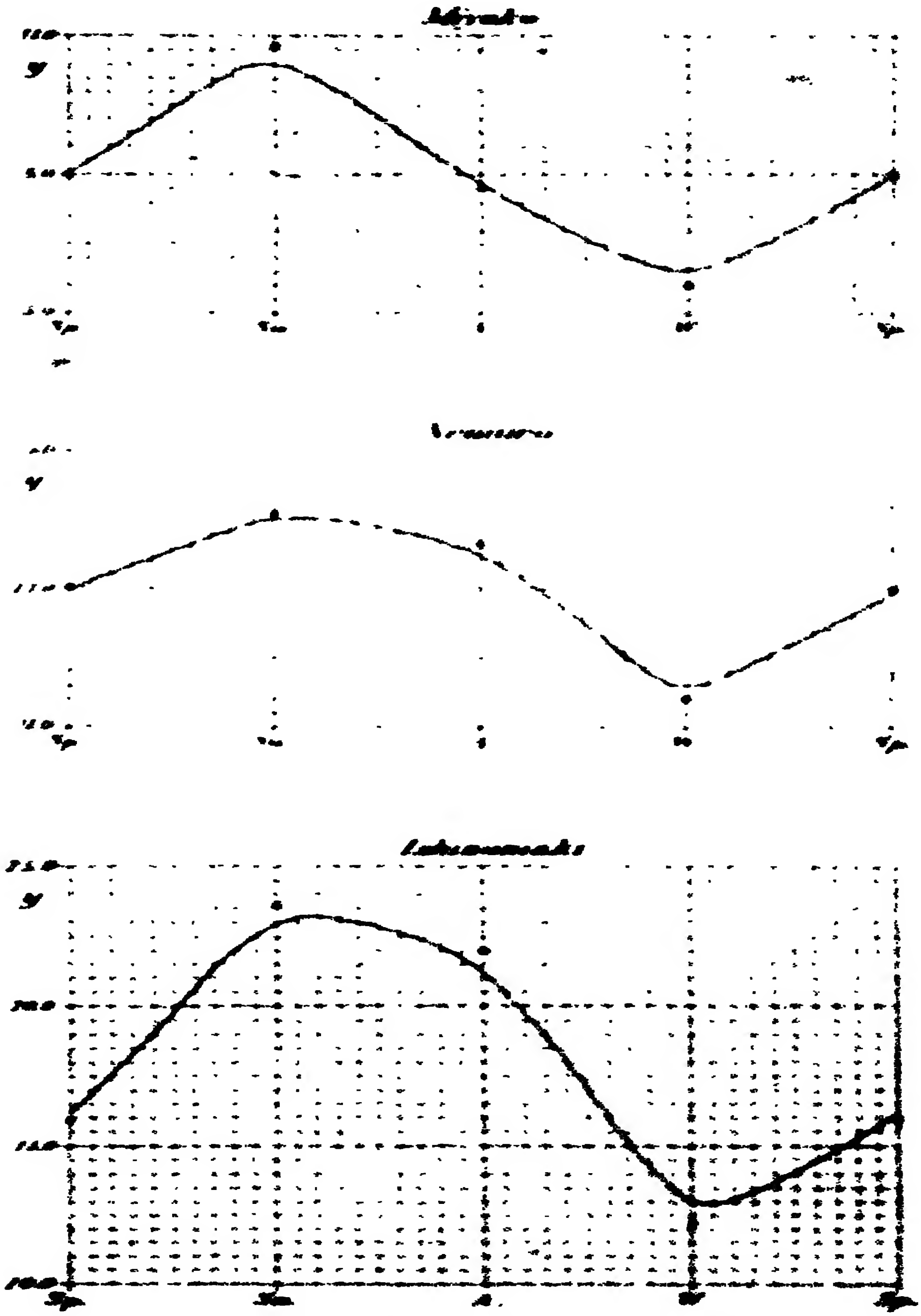
Hakodate, Sapporo and Oita.



y = mean seasonal number of earthquakes.

Fig. 5, (1). Seasonal Variation of Seismic Frequency.

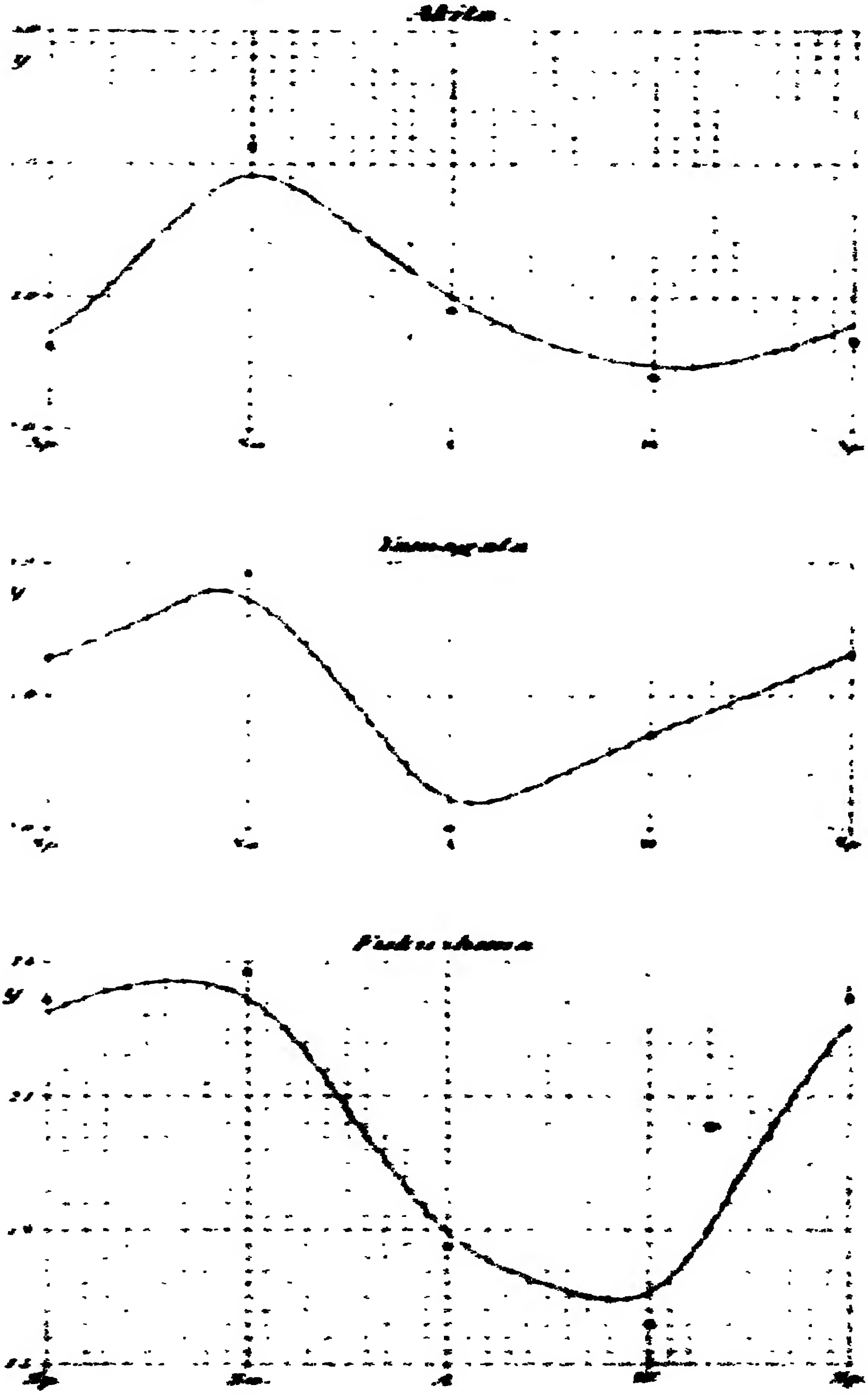
Miyako, Nemuro and Ishinomaki.



y = mean monthly number of earthquakes.

Fig. 5, (2). Seasonal Variation of Seismic Frequency.

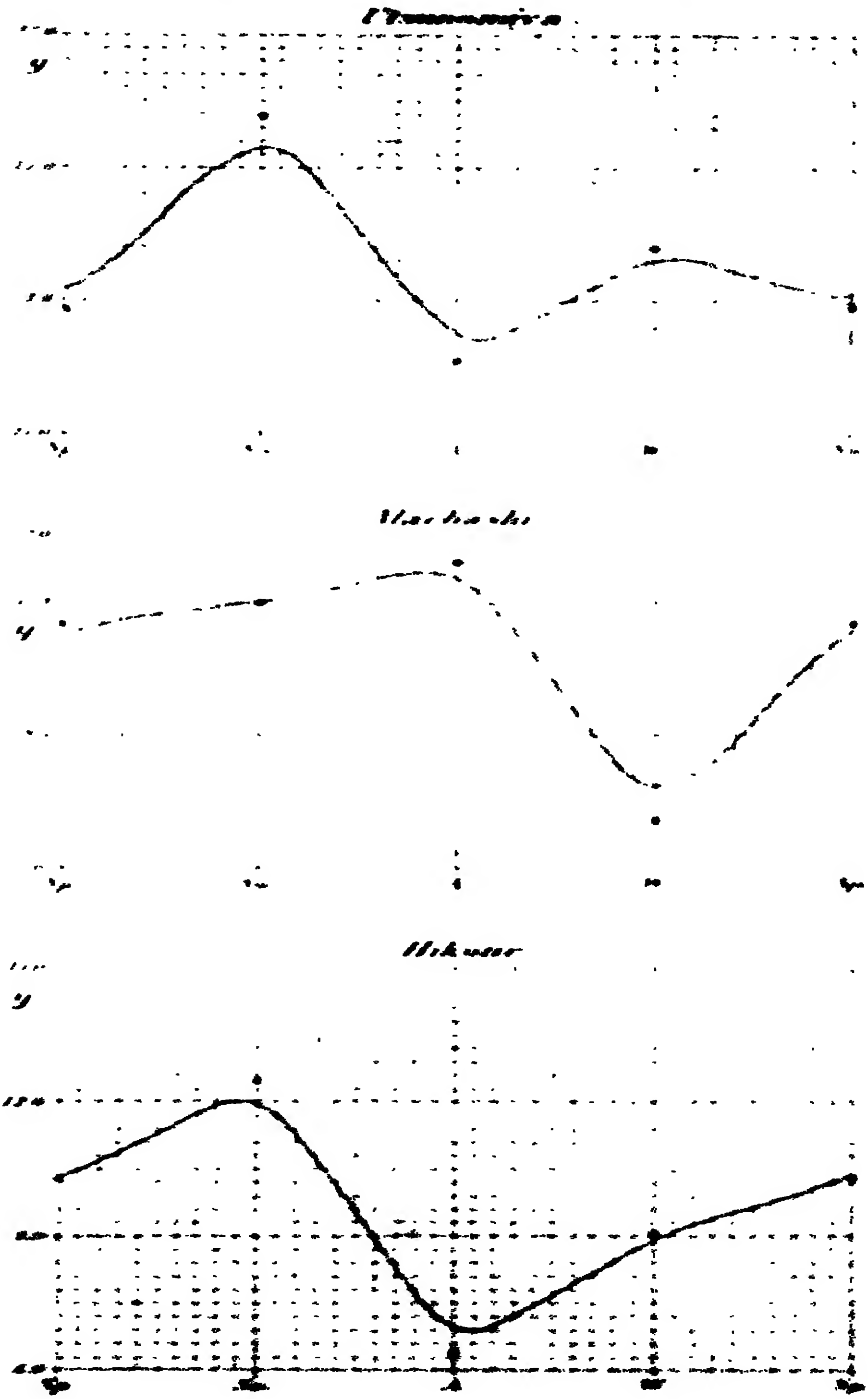
Akita, Yamagata and Fukushima.



Mean monthly number of earthquakes.

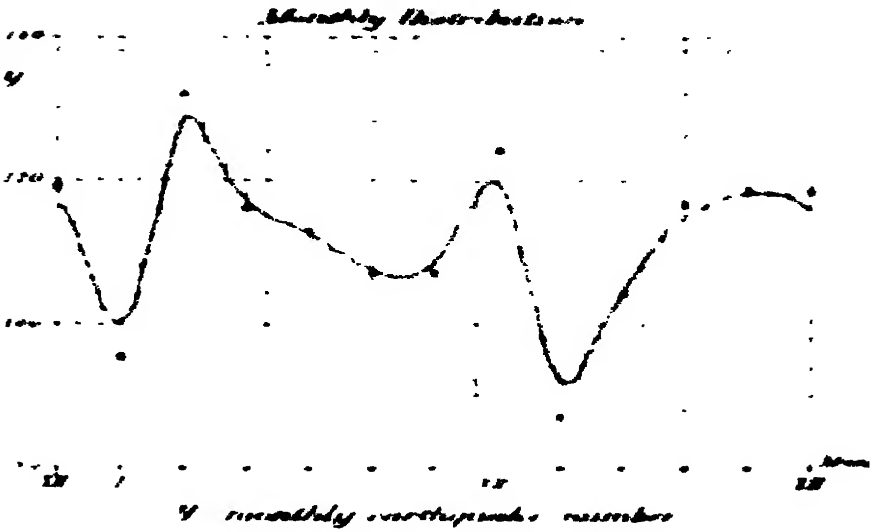
Fig. 5. (3). Seasonal Variation of Seismic Frequency

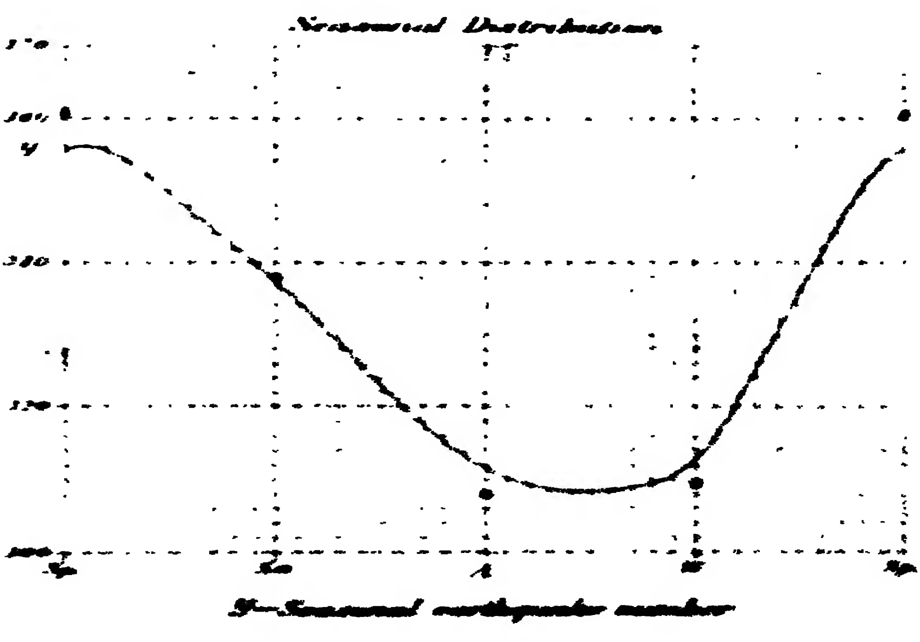
Utsunomiya, Maebashi and Hikone.



y = mean monthly number of earthquakes.

Fig. 6. Annual Distribution of 1318 (Destructive and Small) Earthquakes at Kyoto.





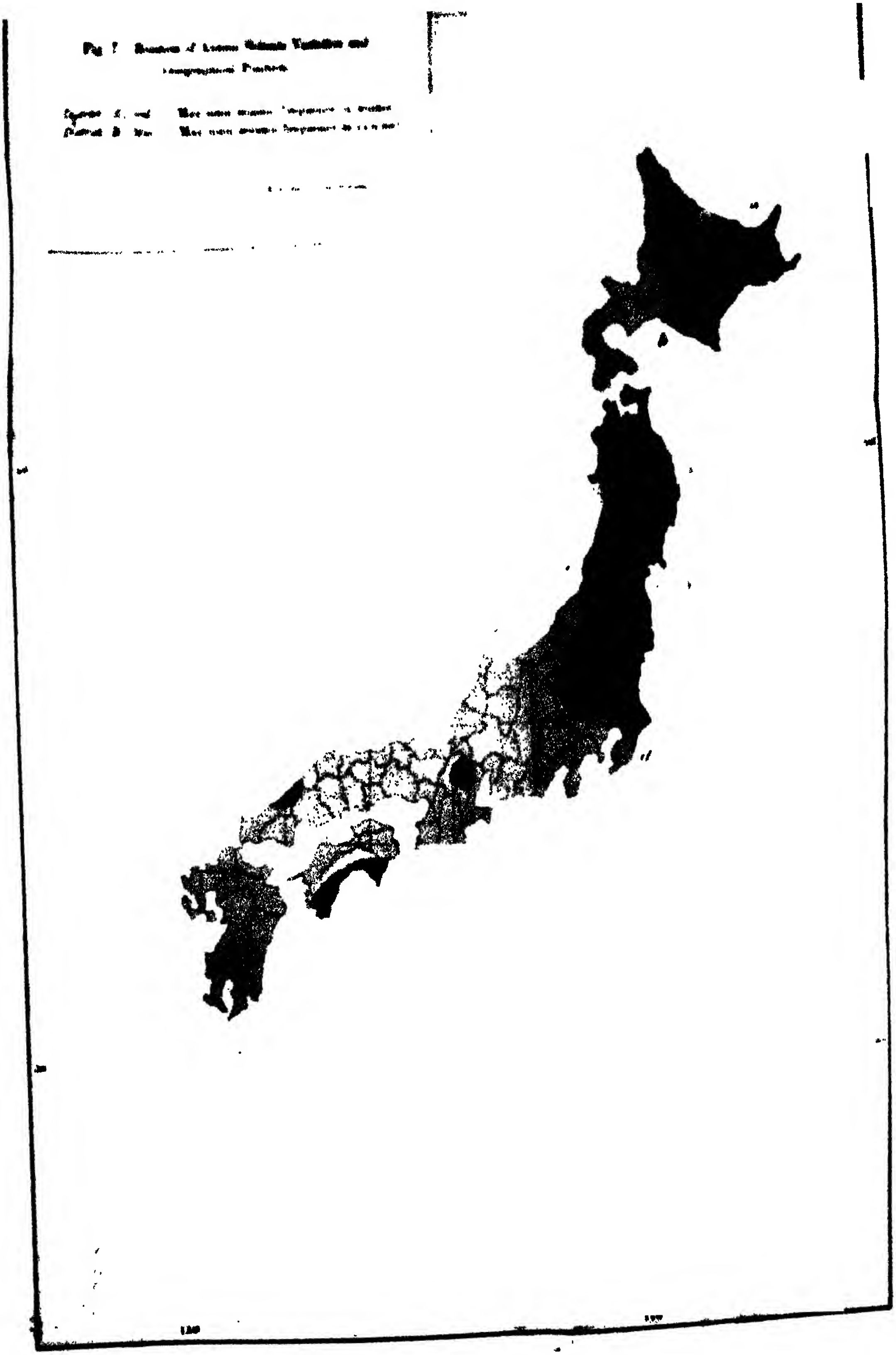
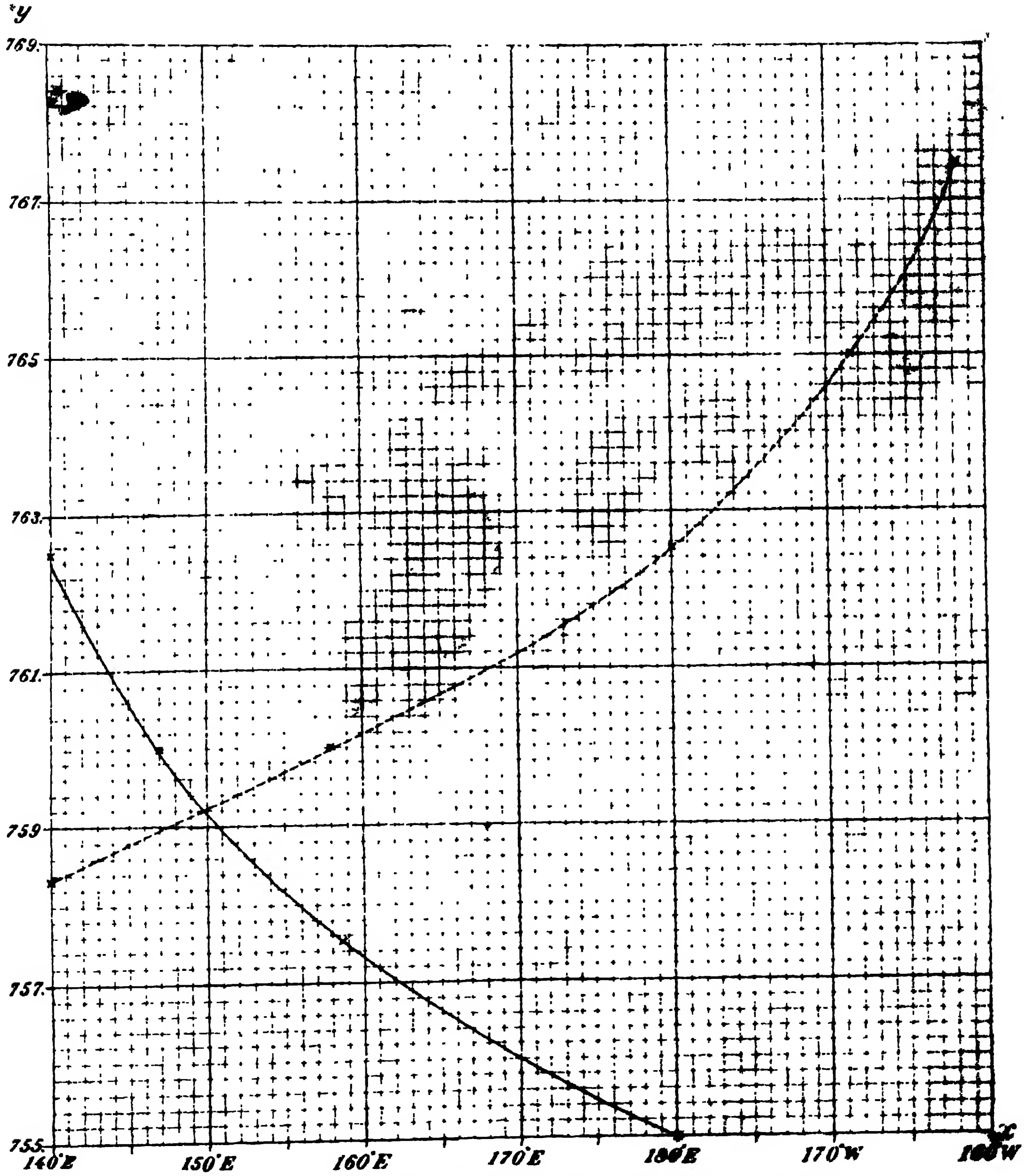


Fig. 8. Distribution of Barometric Pressure in the Northern Pacific.

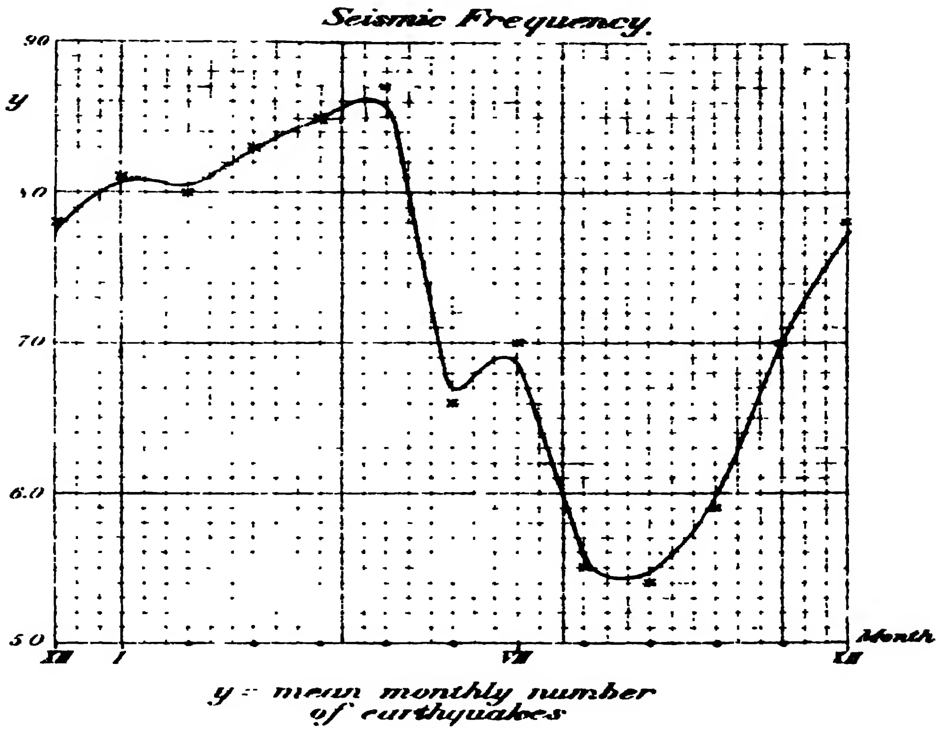
{Dotted curve is for July and August.
{Full curve is for January and February.



X—distance measured towards the east, the origin being at a point lat. 40° N, long. 140° E (vicinity of Akita).
Longitude is counted from Greenwich.
Y—barometric pressure, in mm.

Fig. 9, (1). Annual Variations of Seismic Frequency and Barometric Pressure.

Tokyo.



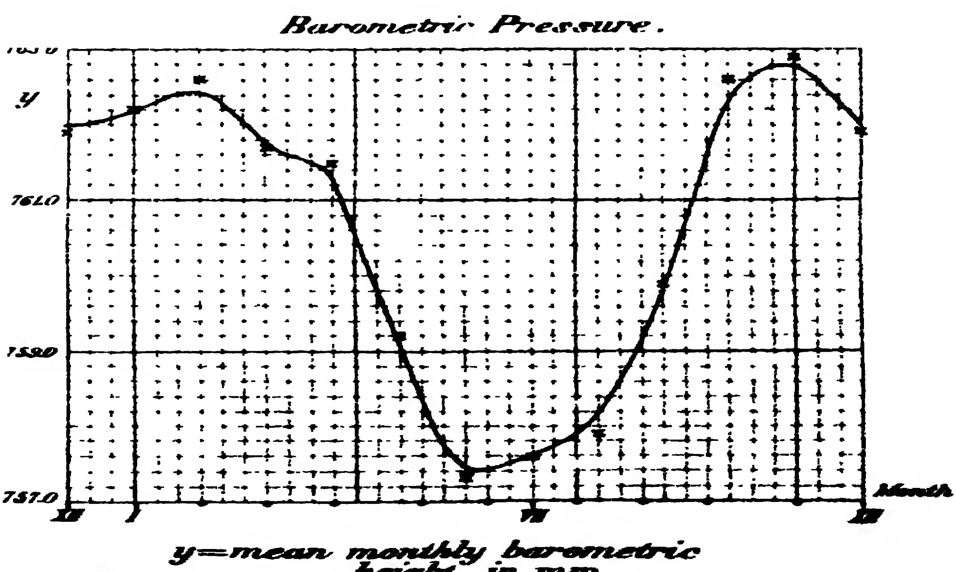
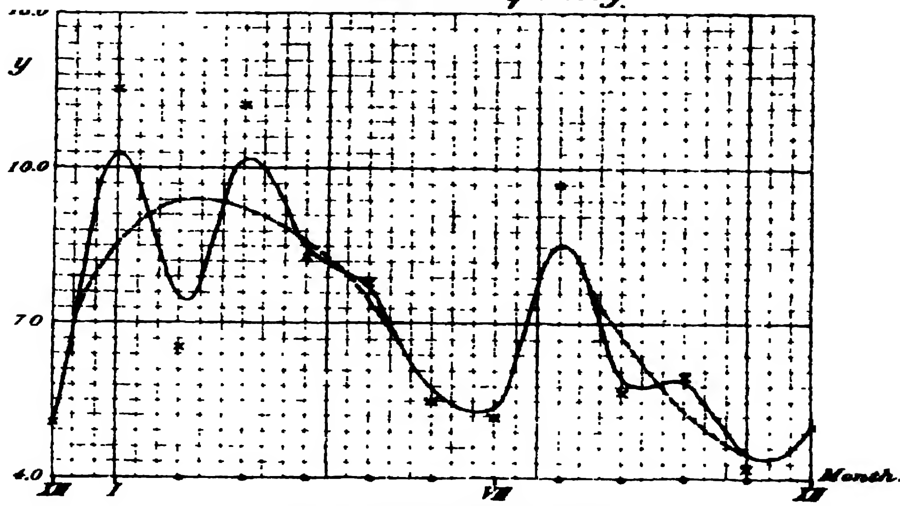


Fig. 9, (2). Annual Variations of Seismic Frequency and Barometric Pressure.

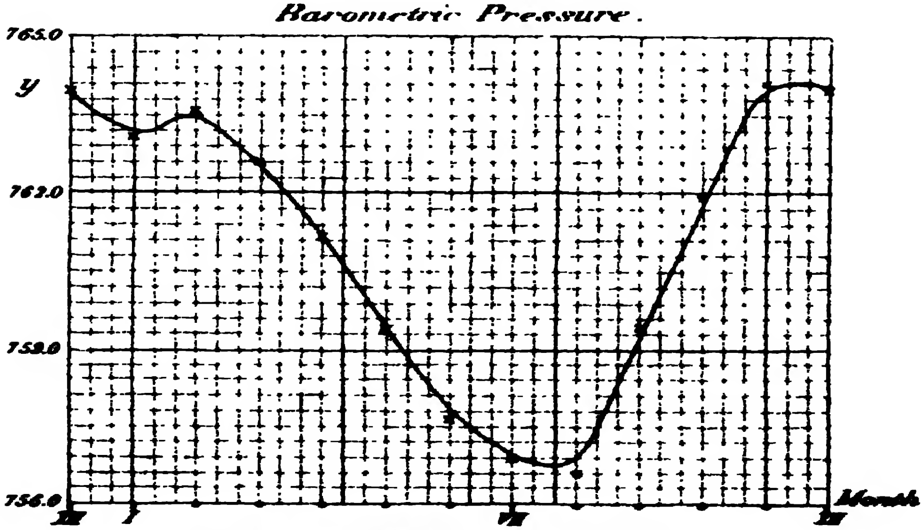
Nagoya.

Seismic Frequency.



y = mean monthly number of earthquakes.

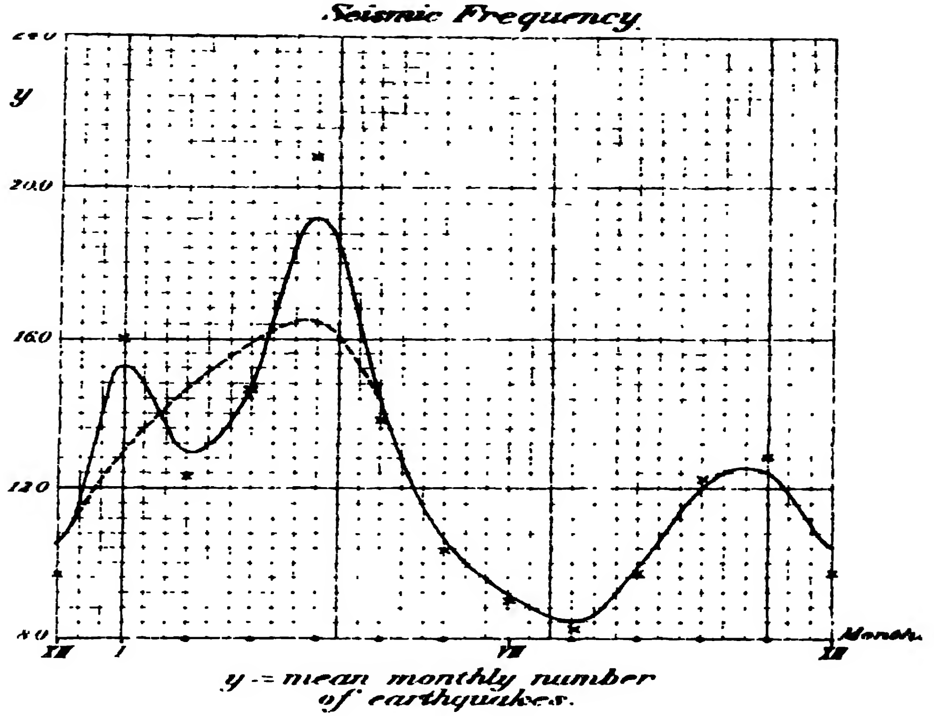
Barometric Pressure.



y = mean monthly barometric height, in mm.

Fig. 9, (3). Annual Variations of Seismic Frequency and Barometric Pressure.

Gifu.



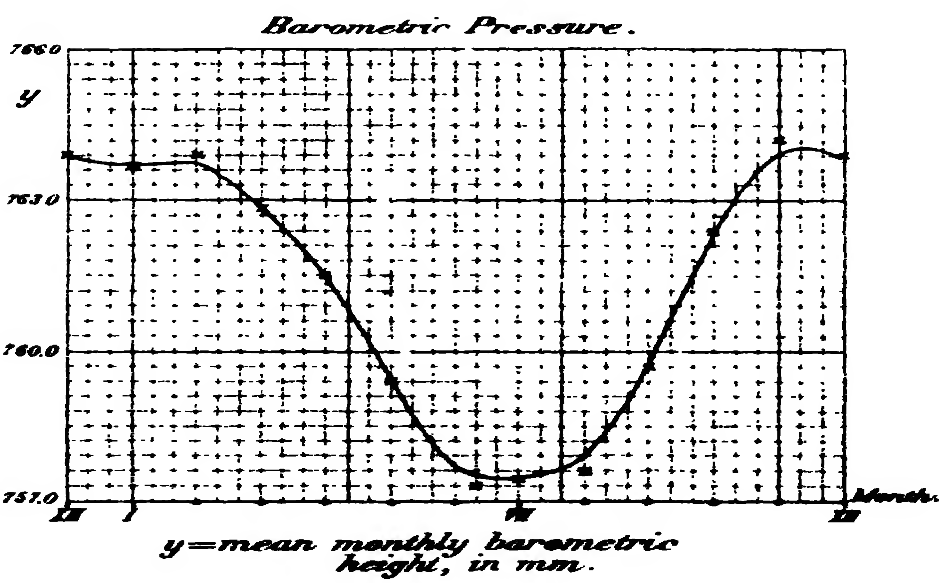
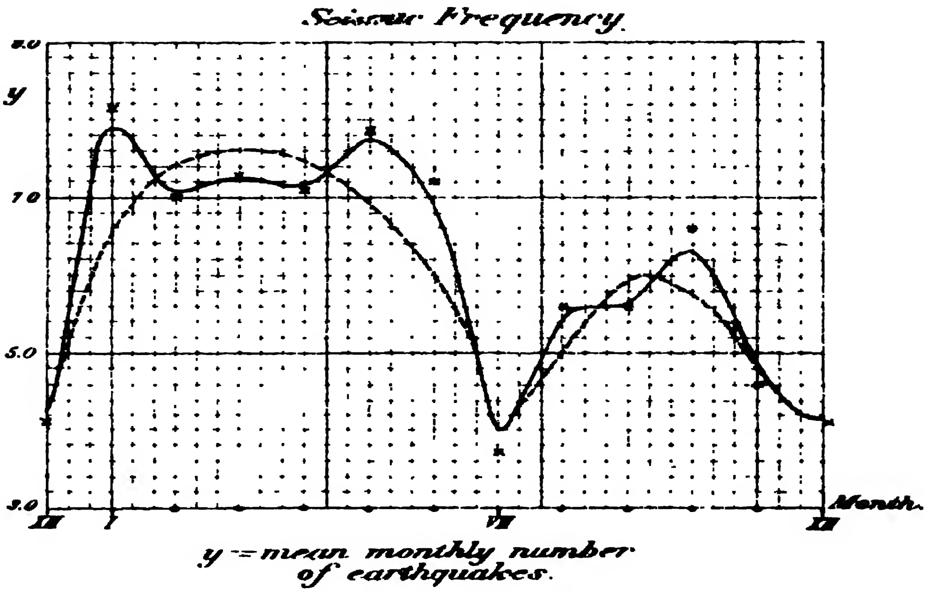


Fig. 9, (4). Annual Variations of Seismic Frequency and Barometric Pressure.

Kumamoto.



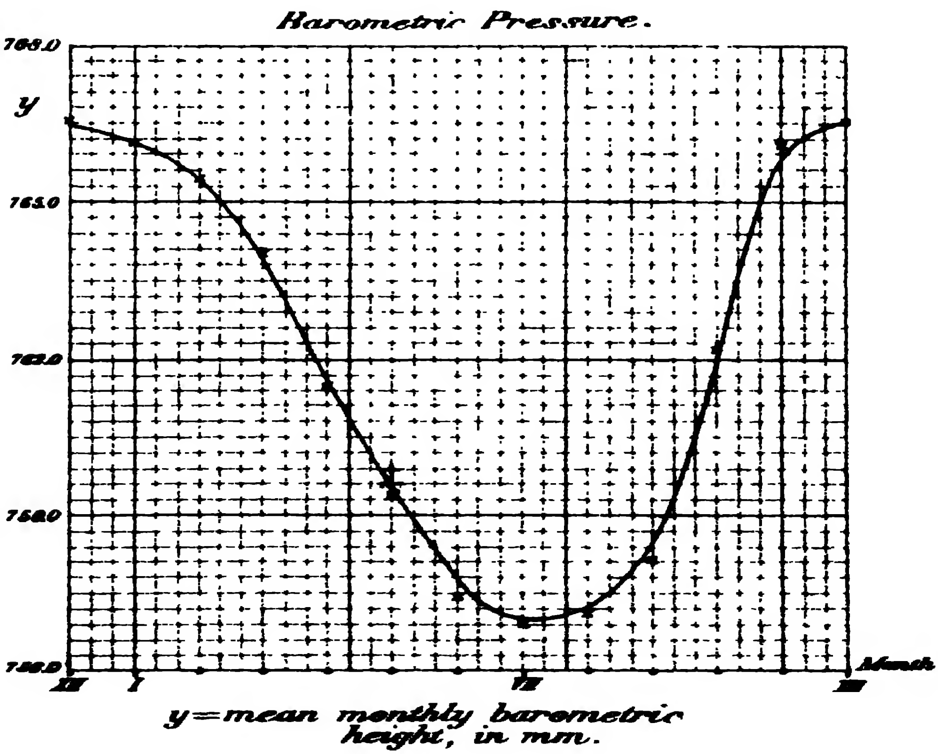
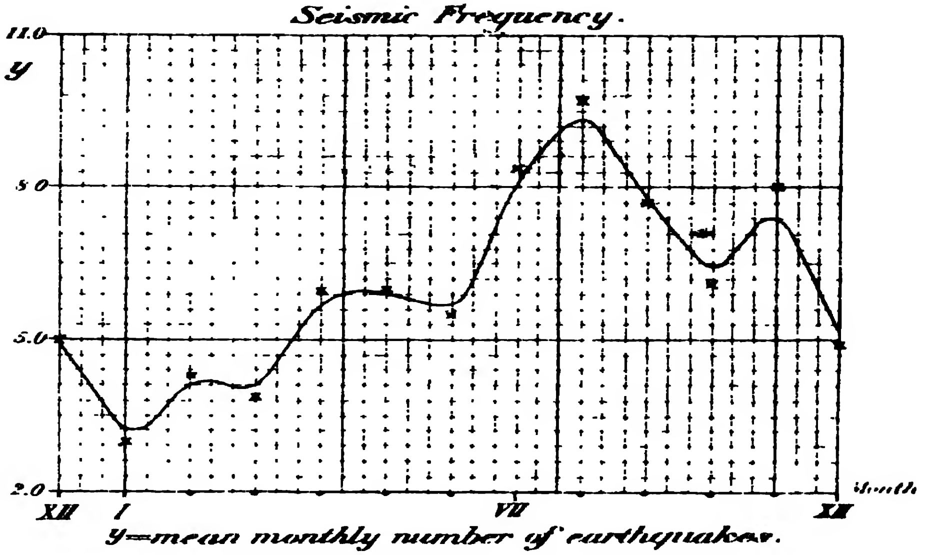


Fig. 10, (1). Annual Variation of Seismic Frequency and Barometric Pressure. *Ishinomaki.*



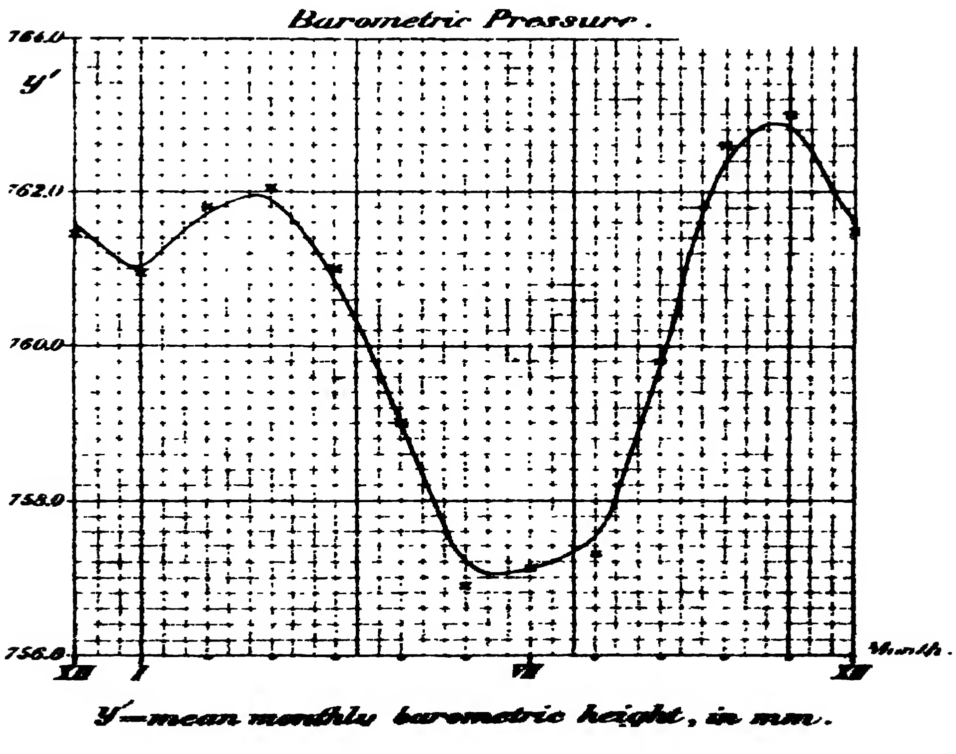
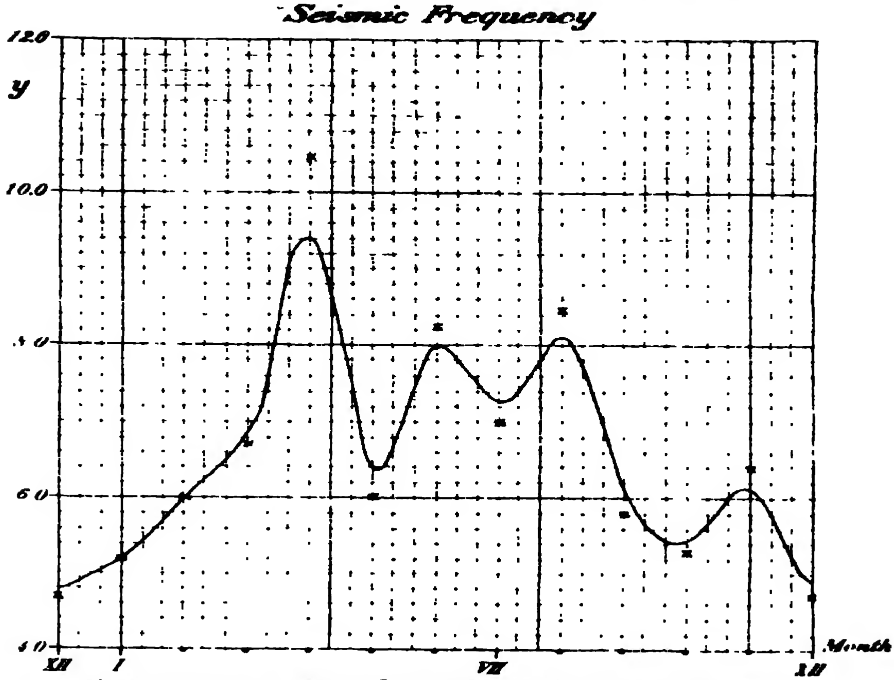
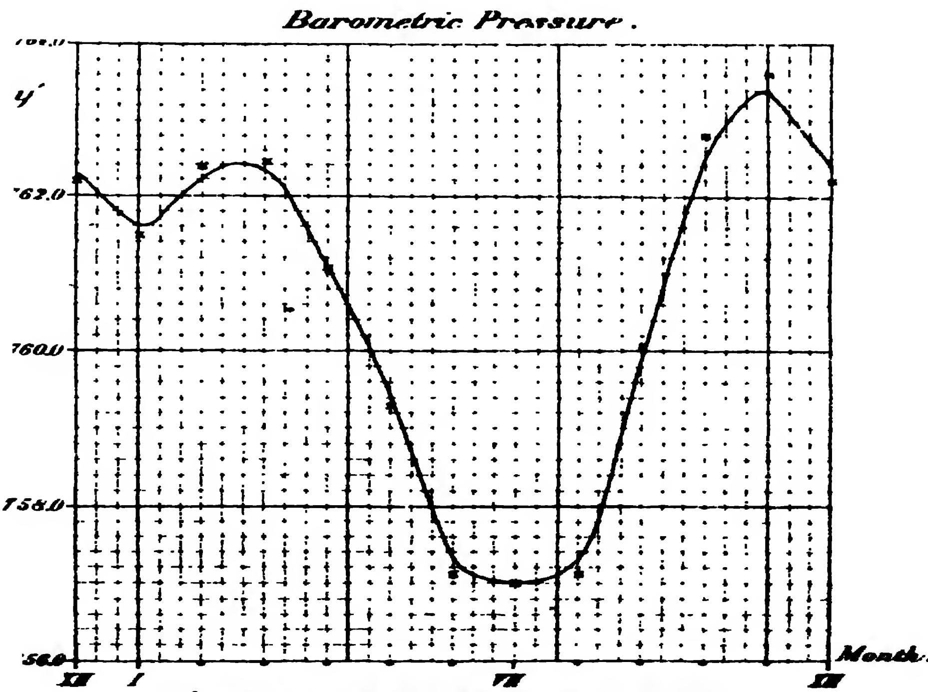


Fig. 10, (2). Annual Variation of Seismic Frequency and Barometric Pressure. *Fukushima.*

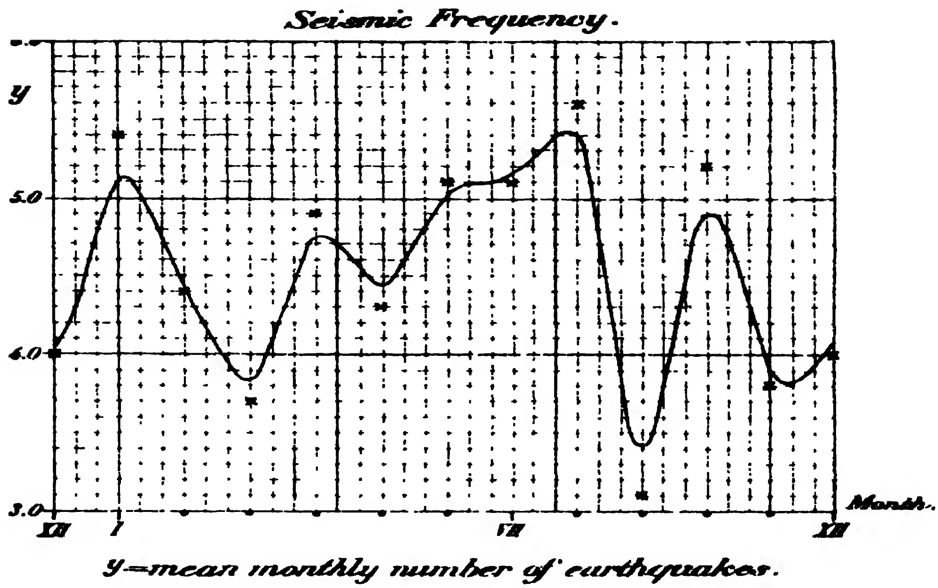


y = mean seasonal number of earthquakes.



y′ = mean monthly barometric height, in mm.

Fig. 10, (3). Annual Variation of Seismic Frequency and Barometric Pressure. *Utsunomiya.*



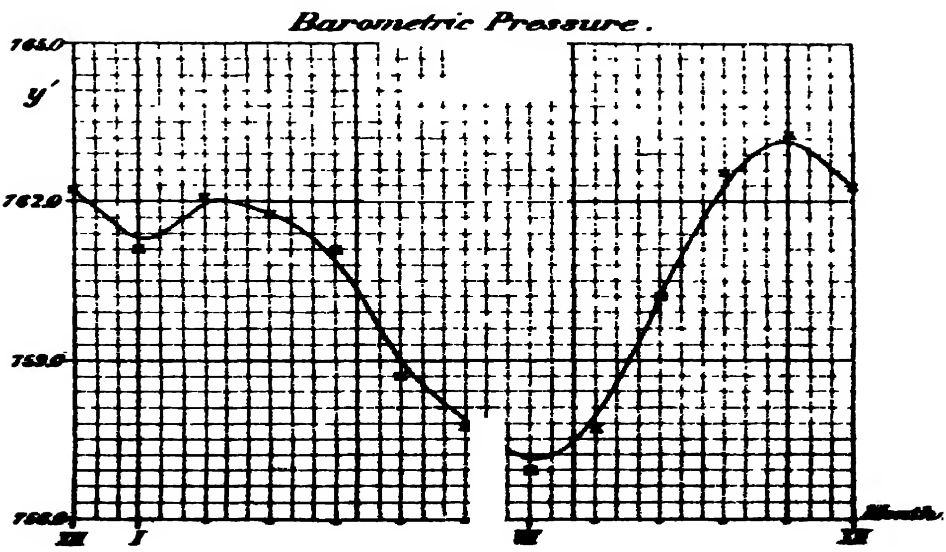
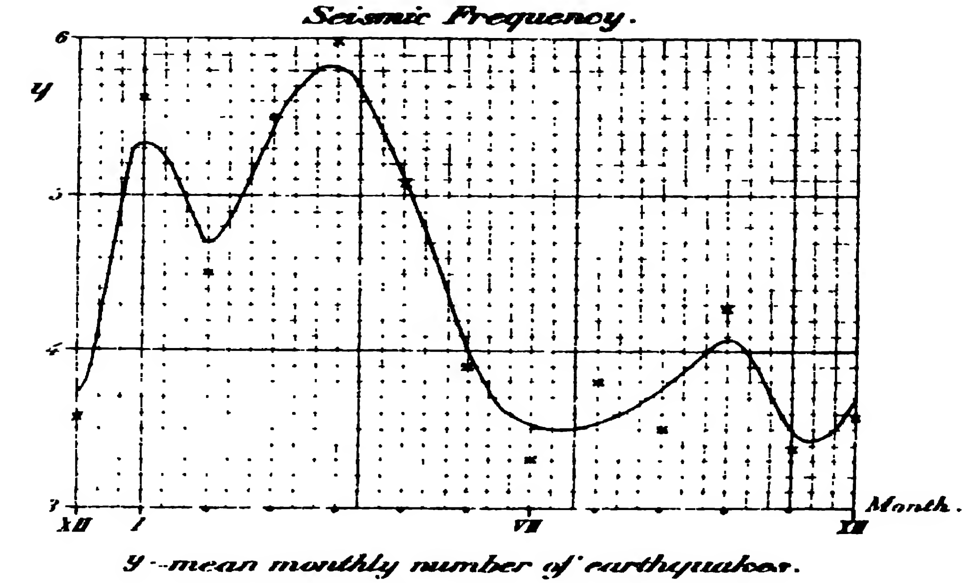


Fig. 11, (1). Annual Variation of Seismic Frequency and Barometric Pressure. *District* [*A*].



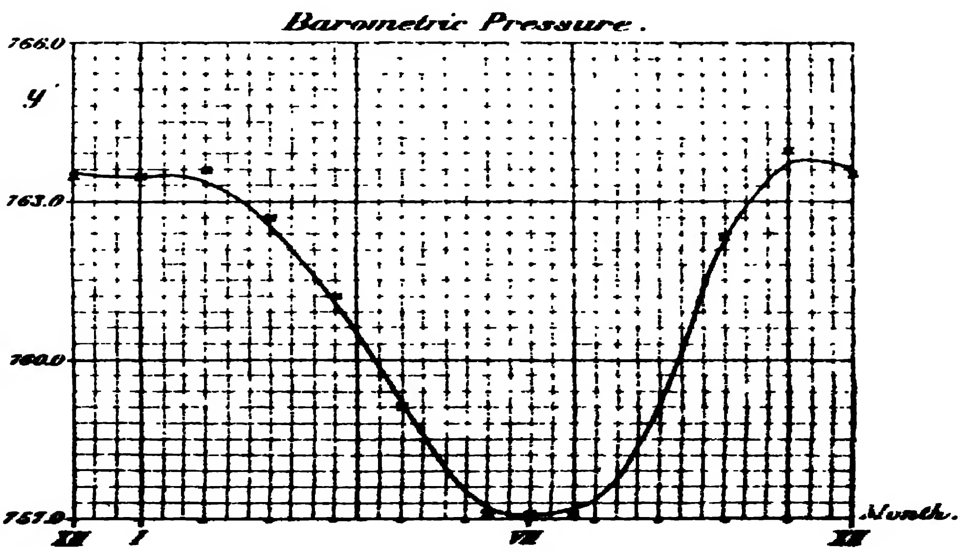


Fig. 12. Seasonal Variation of Seismic Frequency and Barometric Pressure. ***Whole Japan.***

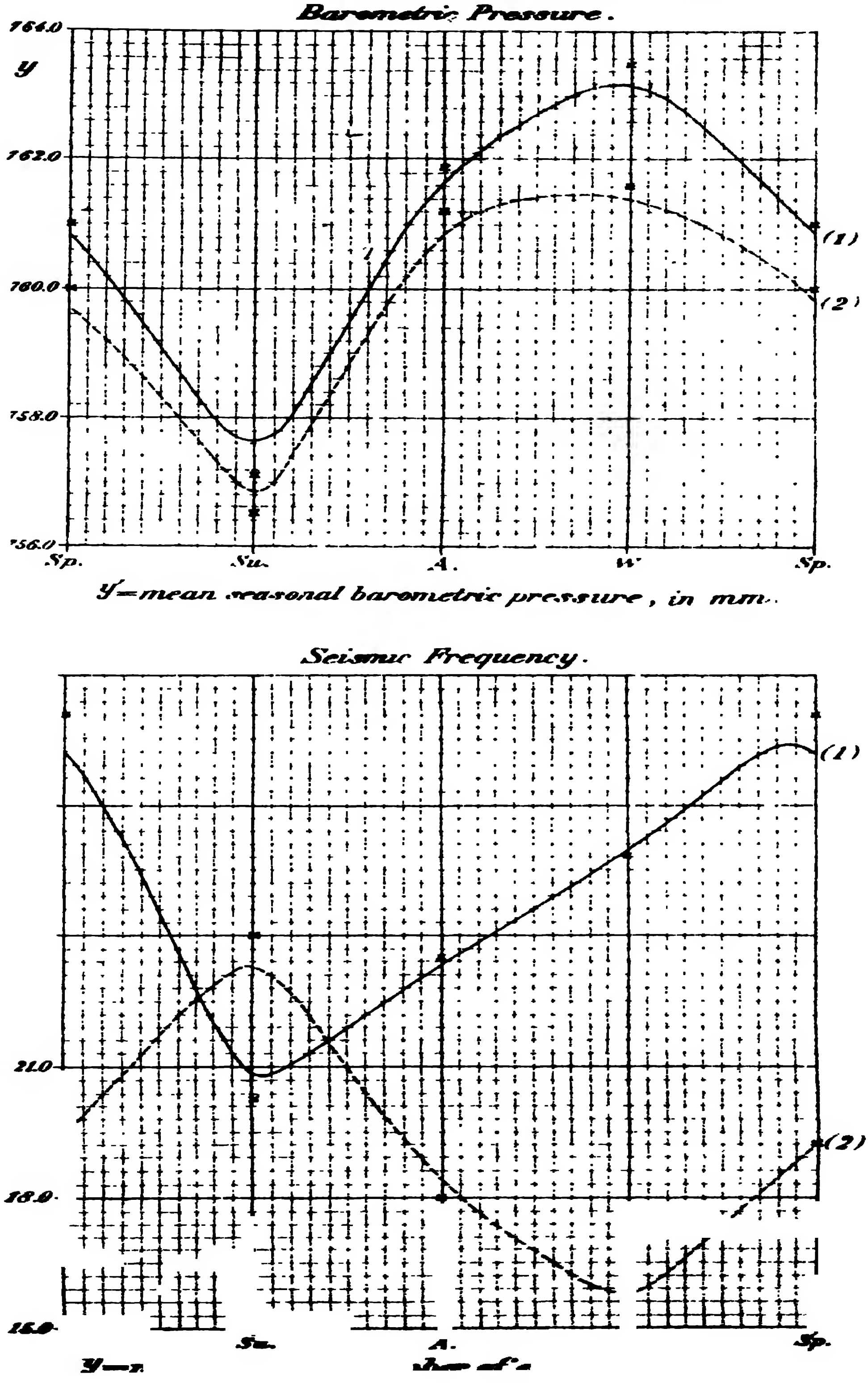
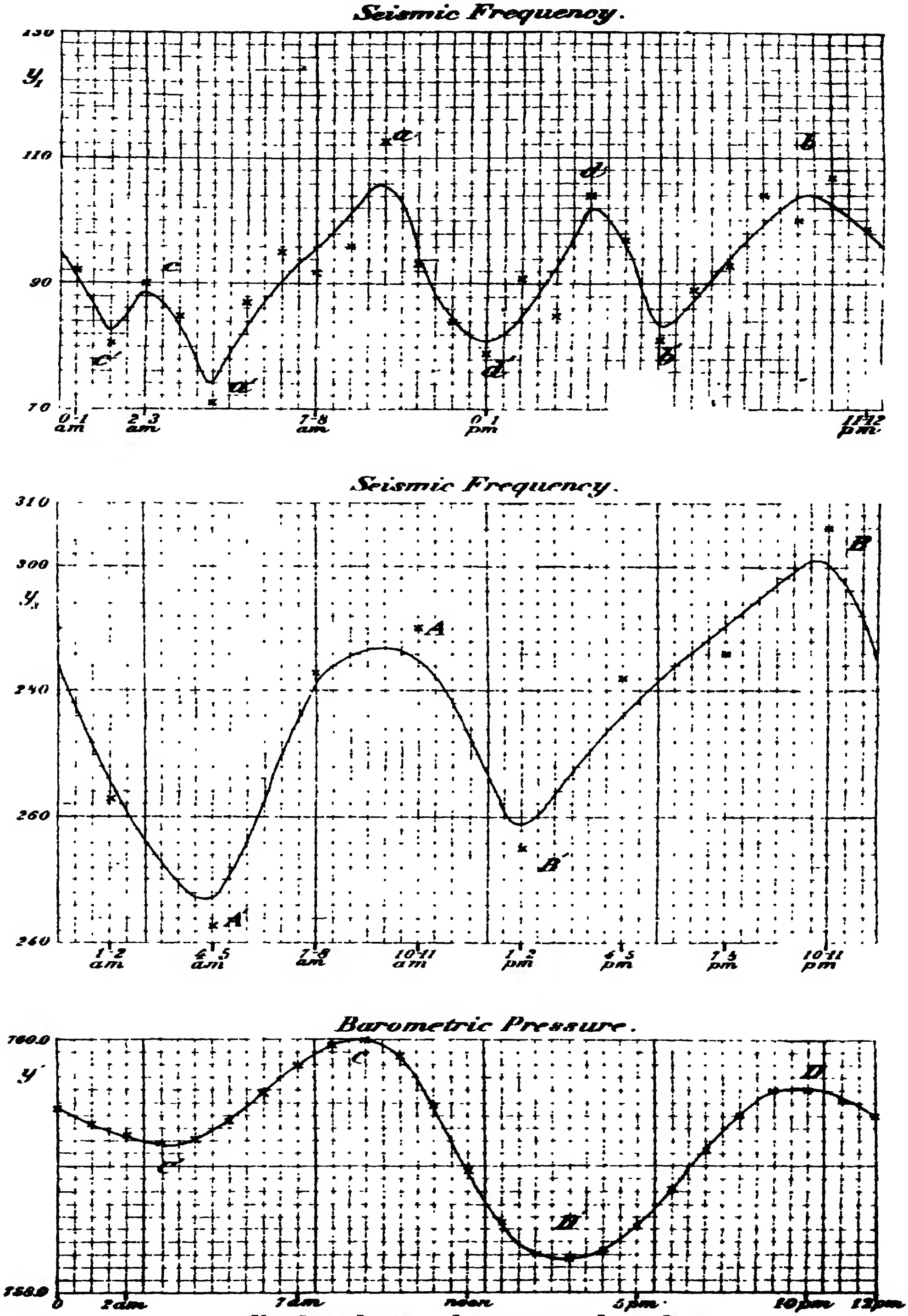


Fig. 13, (1). Diurnal Variations of Seismic Frequency and Barometric Pressure.

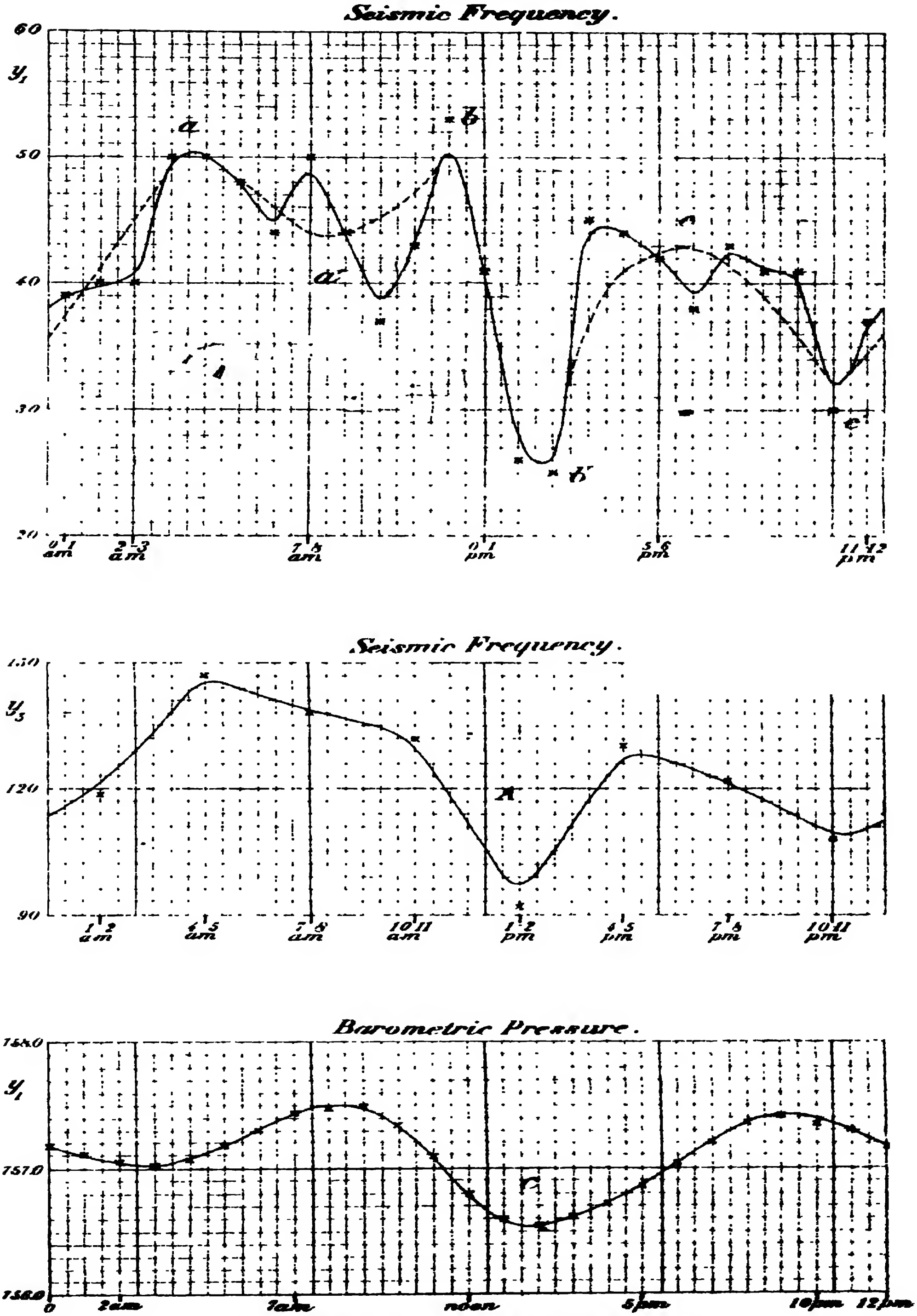
Tokyo.



y_1 = hourly number of earthquakes.
y_3 = 3-hourly " " "
y' = mean barometric height, in mm.

Fig. 13, (2). Diurnal Variations of Seismic Frequency and Barometric Pressure.

Nemuro.



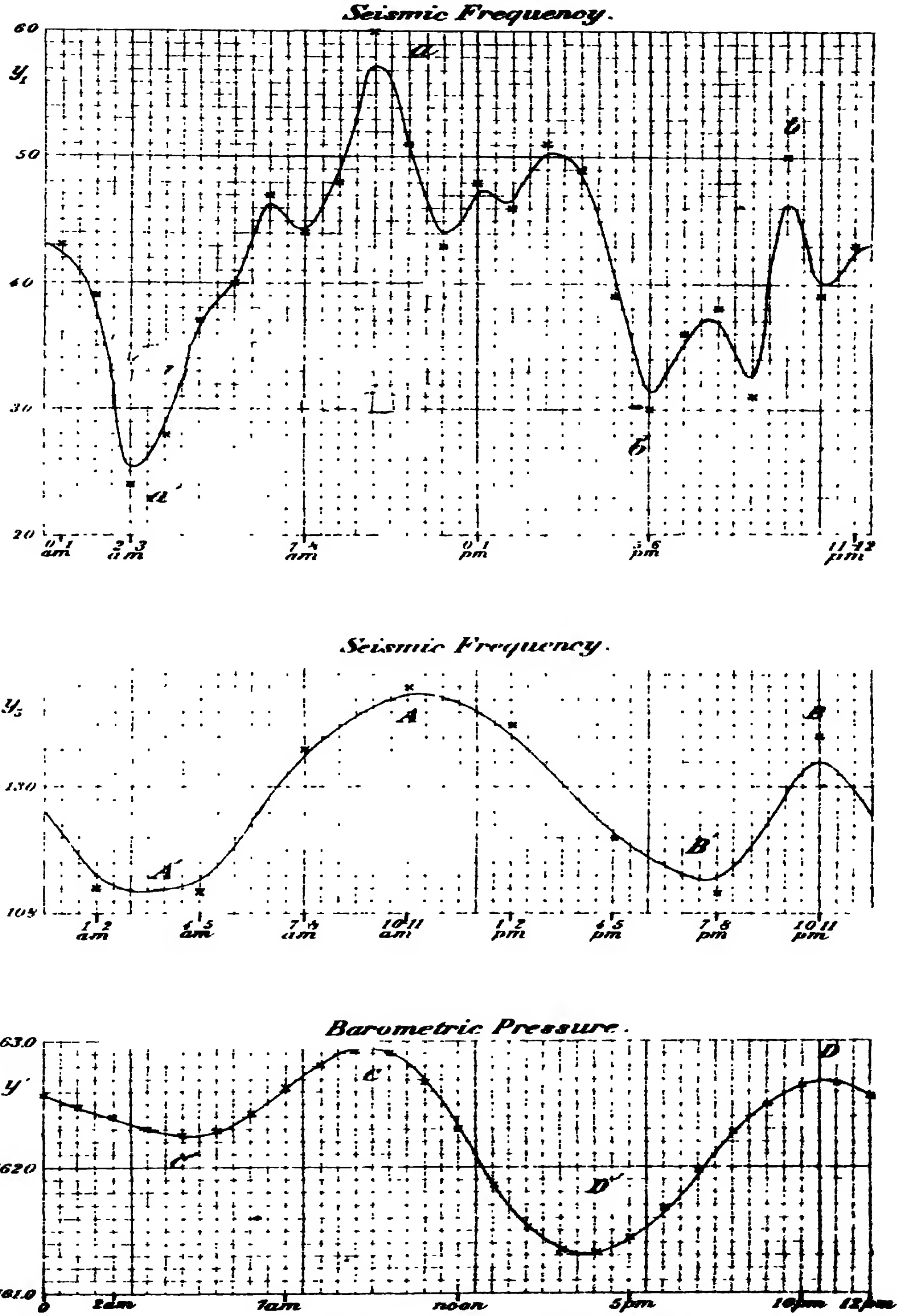
y_1 = hourly number of earthquakes.

y_3 = 3-hourly " " "

y = mean barometric height, in mm.

Fig. 13, (3). Diurnal Variations of Seismic Frequency and Barometric Pressure.

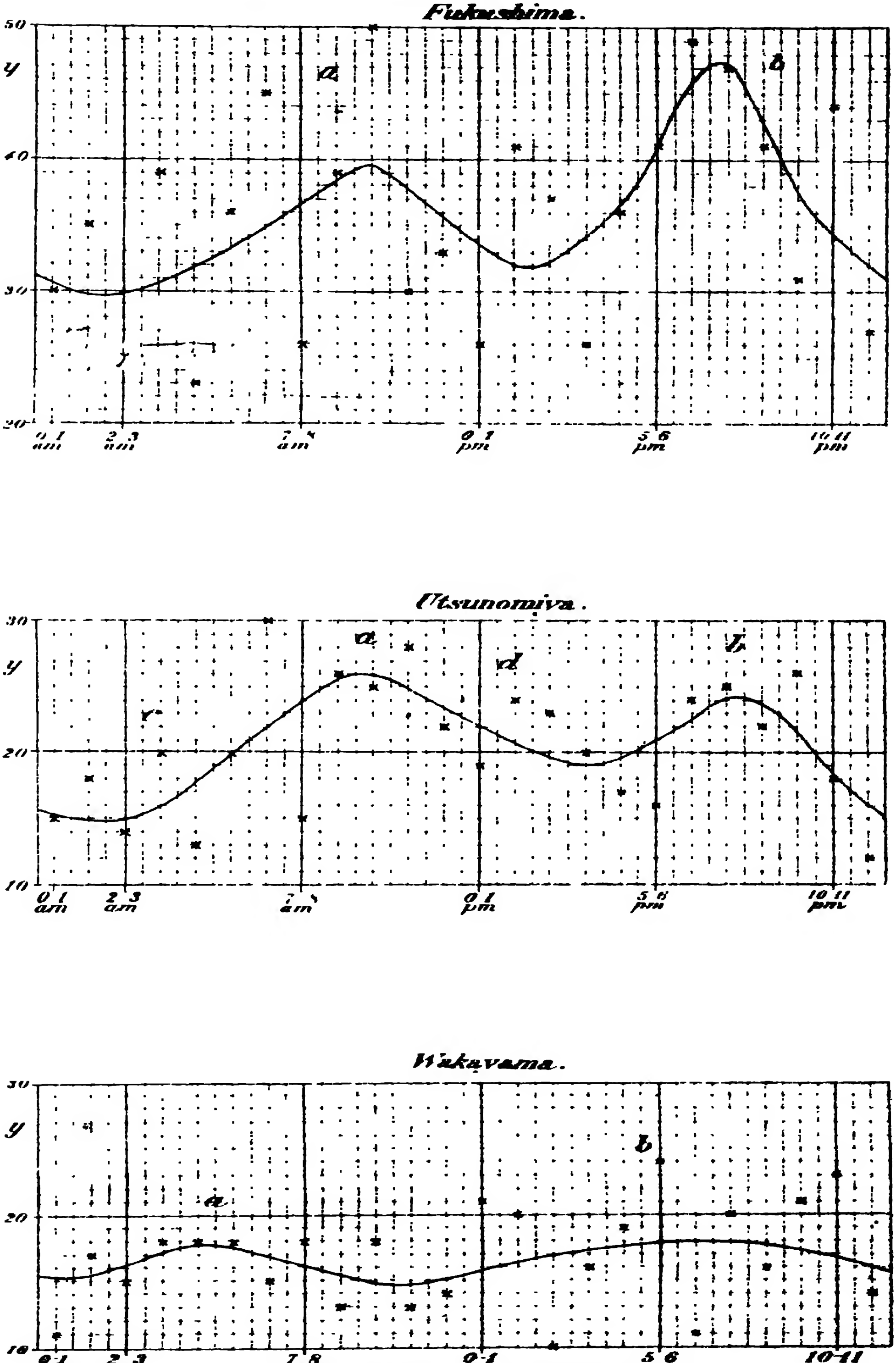
Kumamoto.



y_1 = hourly number of earthquakes.
y_3 = 3-hourly " " "
y' = mean barometric height, in mm.

Fig. 14, (1). Diurnal Variation of Seismic Frequency.

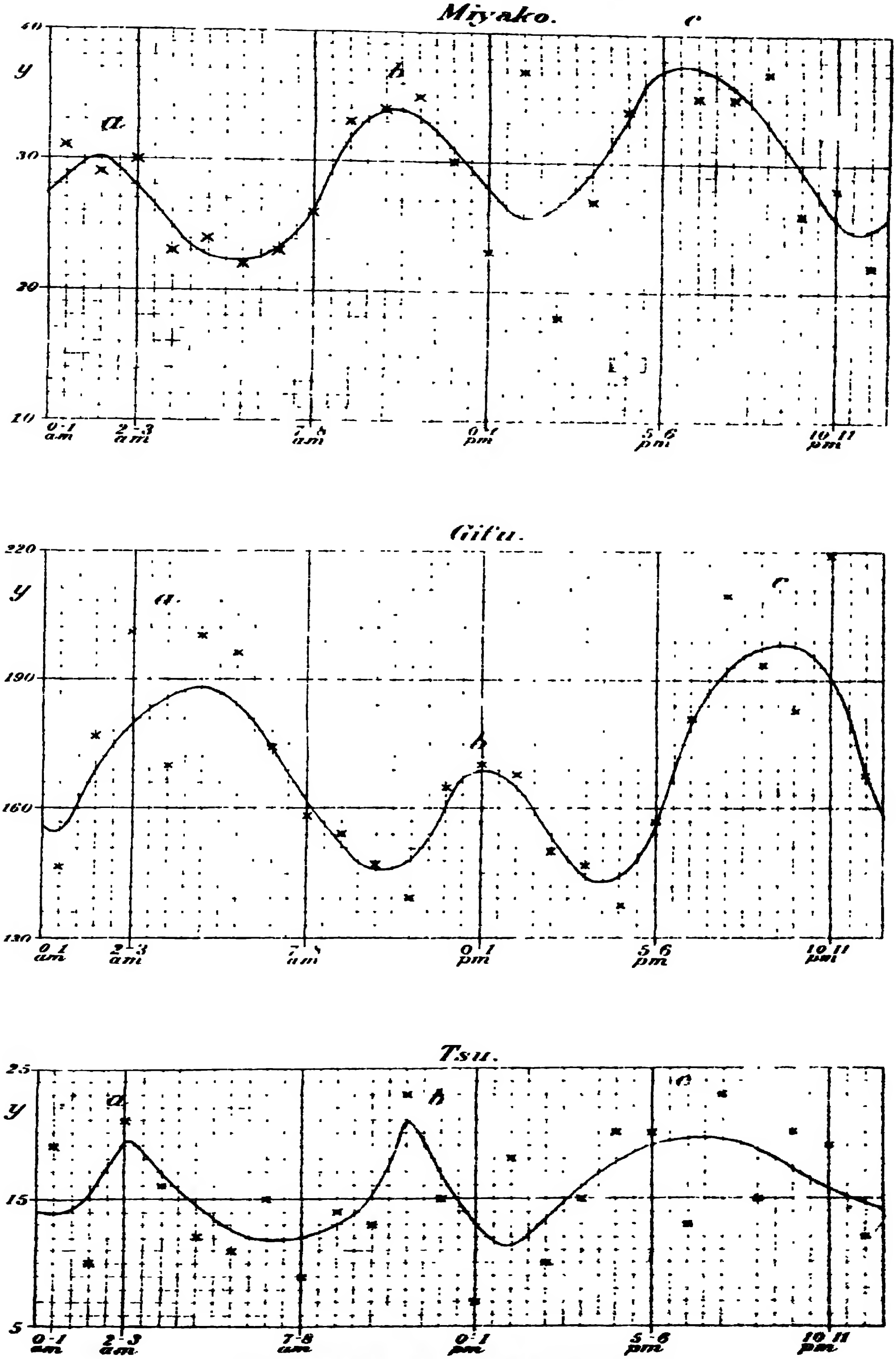
Fukushima, Utsunomiya* and *Wakayama.



y=hourly number of earthquakes.

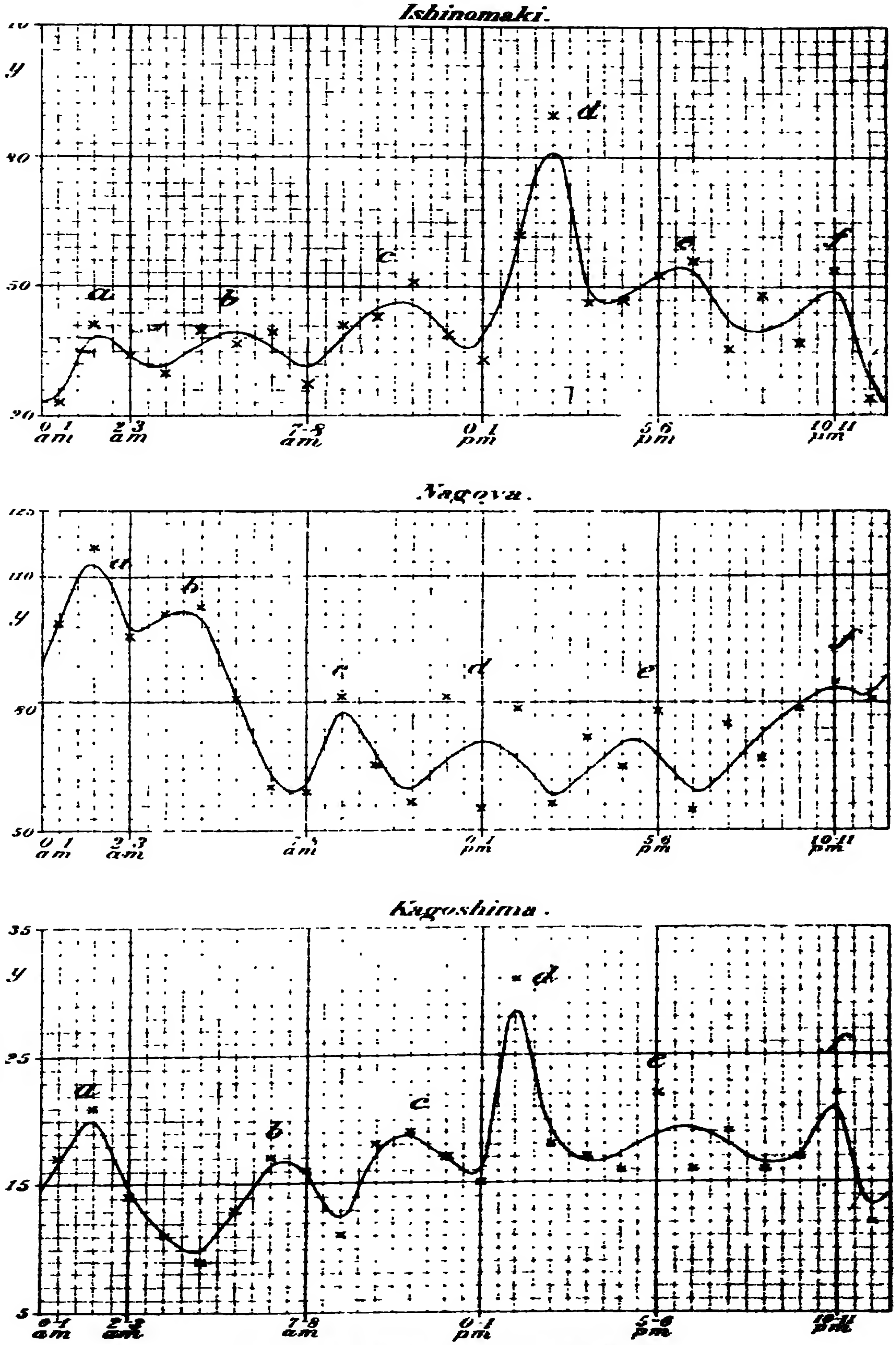
Fig. 14, (2). Diurnal Variation of Seismic Frequency.

Miyako, Gifu* and *Tsu.



y = hourly number of earthquakes.

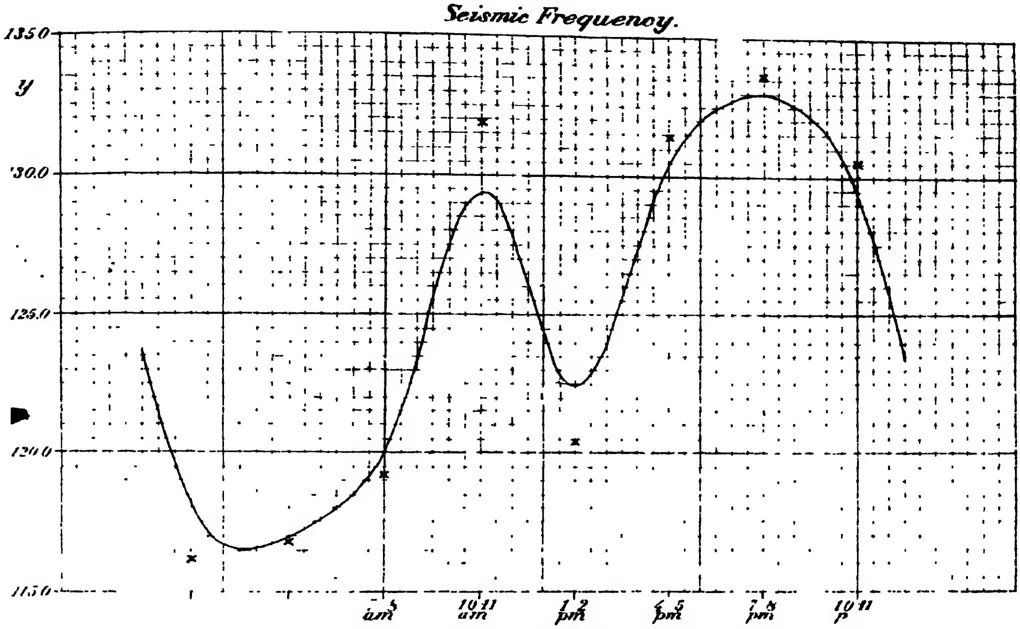
Fig. 14, (3). Diurnal Variation of Seismic Frequency.
Ishinomaki, Nagoya and Kagoshima.



y = hourly number of earthquakes.

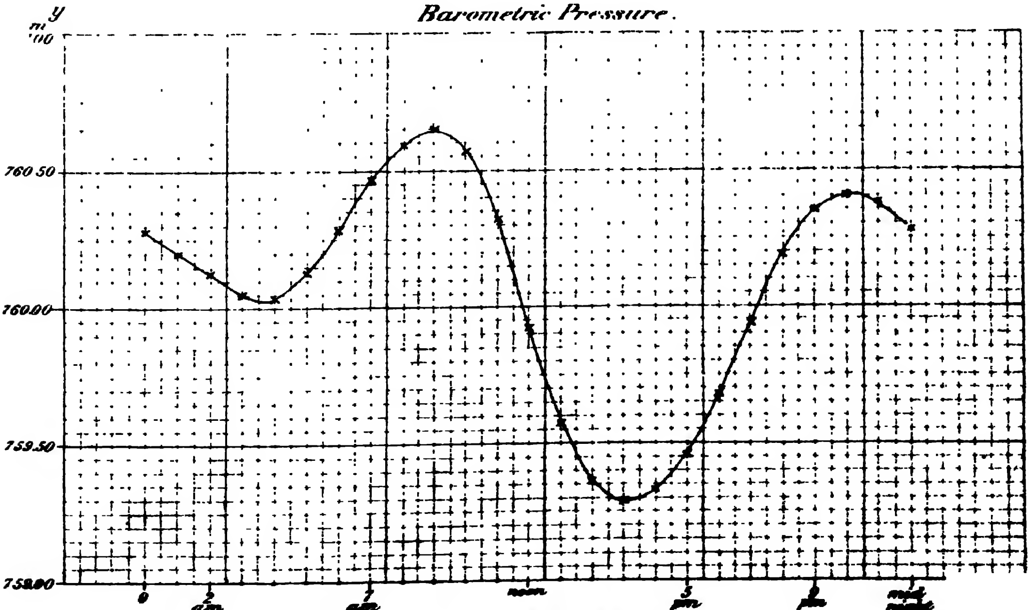
Fig. 15. Diurnal Variation of Seismic Frequency and Barometric Pressure. ***Whole Japan.***

Seismic Frequency.



y=3-hourly seismic frequency for whole Japan. (See Table XV.)

Barometric Pressure.



y=mean barometric height for whole Japan. (See Table XIV.)

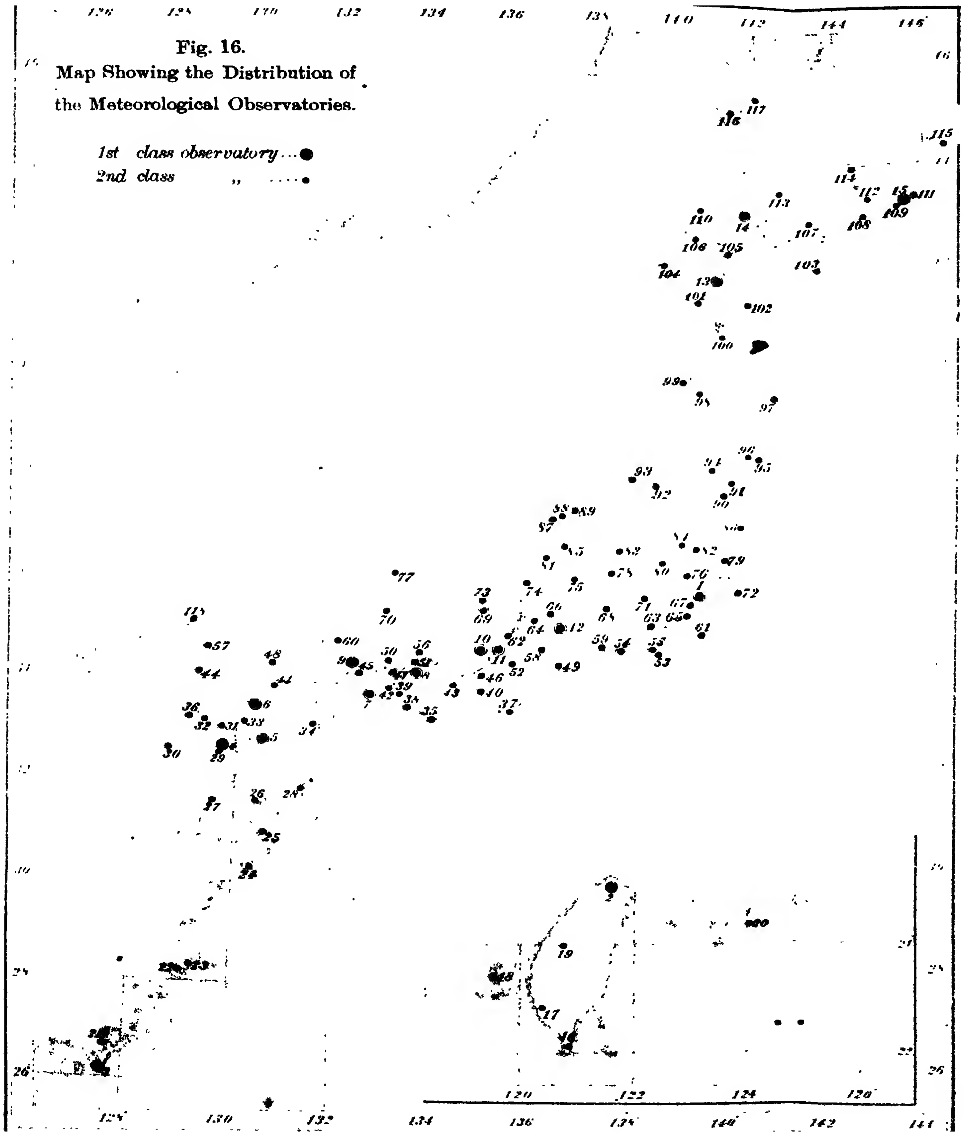


Fig. 16.
Map Showing the Distribution of the Meteorological Observatories.

LIST OF METEOROLOGICAL OBSERVATORIES.*

No.	Meteor Observatory.	No.	Meteor Observatory.	No.	Meteor Observatory.
1	Chūōkishodai.	44	Izugahara.	87	Minazuki.
2	Taihoku.	45	Kure.	88	Wajima.
3	Naha.	46	Wakayama.	89	Rokkōzaki.
4	Nagasaki.	47	Momonukizima.	90	Fukushima.
5	Kumamoto.	48	Kakuzima.	91	Kanayama.
6	Fukuoka.	49	Anzyozaki	92	Niigata.
7	Matsuyama.	50	Matsunaga.	93	Hinozaki.
8	Tadotsu.	51	Ajino.	94	Yamagata.
9	Hiroshima.	52	Yagi.	95	Kinkazan.
10	Kōbe.	53	Mikomotozima.	96	Ishinomaki.
11	Ōsaka.	54	Omaezaki.	97	Miyako.
12	Nagoya.	55	Nagatsuro.	98	Akita.
13	Hakodate.	56	Okayama.	99	Nyūdōzaki.
14	Sapporo.	57	Mishima.	100	Aomori.
15	Nemuro.	58	Tsu	101	Shiragamizaki.
16	Kōshun.	59	Hamamatsu.	102	Shiriyazaki.
17	Tainan.	60	Hamada.	103	Yerimo.
18	Hōkotō.	61	Mera	104	Inahozaki.
19	Taichu.	62	Kyoto	105	Muroran.
20	Ishigakijima.	63	Numazu	106	Suttsu.
21	Iyejima.	64	Hikone.	107	Tokachi.
22	Sotsutakazaki.	65	Yokosuka.	108	Kushirozaki.
23	Ōshima.	66	Gifu.	109	Ottishizaki.
24	Yakushima.	67	Yokohama.	110	Kamuimisaki.
25	Satamisaki.	68	Iida.	111	Noshappuzaki.
26	Kagoshima.	69	Miyatsu.	112	Kushiro.
27	Tsurikakezaki.	70	Sakai.	113	Kamikawa.
28	Miyazaki.	71	Kōfu.	114	Abashiri.
29	Nomozaki.	72	Chōshi.	115	Atoyeyamisaki.
30	Ōsezaki.	73	Kyōgamisaki.	116	Oshidomari.
31	Sasebo.	74	Fukui.	117	Sōya.
32	Shijikizaki.	75	Takayama.	118	Fuzan.
33	Saga.	76	Kumagai.		
34	Ōita.	77	Saigō.		
35	Murotozaki.	78	Matsumoto.		
36	Kojikizaki.	79	Mito.		
37	Shiomisaki.	80	Mayebashi.		
38	Kōchi.	81	Kanazawa.		
39	Besshi.	82	Utsunomiya.		
40	Hinomisaki.	83	Nagano.		
41	Akamagaseki.	84	Ashio.		
42	Niihama.	85	Fushiki.		
43	Tokushima.	86	Shioyazaki.		

* This list includes 83 1st and 2nd class observatories and 35 naval and private meteorological stations.

印刷所　三秀舍活版所
東京市神田區美土代町二丁目一番地

印刷者　島連太郎
東京市神田區美土代町二丁目一番地

震災豫防調査會

明治三十五年三月四日發行
明治三十五年三月三日印刷